# – Face Value –

## Processing of Emotional Expressions in Social Anxiety

Wolf - Gero Lange

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# In

# Social Anxiety

Colophon

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Een wetenschappelijke proeve
op het gebied van de Sociale Wetenschappen

Proefschrift

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"None of our men are 'experts'. We have most unfortunately found it necessary to get rid of a man as soon as he thinks himself an expert because no one ever considers himself expert if he really knows his job. A man who knows a job sees so much more to be done than he has done, that he is always pressing forward and never gives up an instant of thought to how good and how efficient he is. Thinking always ahead, thinking always of trying to do more, brings a state of mind in which nothing is impossible. The moment one gets into the 'expert' state of mind a great number of things become impossible."

– Henry Ford –

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Chapter 1

# Face Processing and Social Anxiety

*"Your face is a book, where men may read strange matters"*

*– William Shakespeare –*

… Imagine that there were pills that left you without anxiety for whatever circumstance. An individual deprived of all anxiety would very likely be doomed to short life: He would step too close to a cliff, cross a busy street when the gap between cars is too small, get stuck in a narrow passage between caves, drive too fast, be bitten/killed by dogs, snakes or, as in former times predators, behave unsocial, rude, engage in fighting, become outcast, and so on. Thus, it seems as if a certain degree of anxiety has been quite useful in order to ascertain survival in ancient, and is still useful in modern times …

Anxiety can be seen as a threefold set of responses to a threatening situation: Information processing (cognition), physiological activation, and behavior initiation/inhibition (Lang, 1985). Relevant information of context and environment must be analyzed and filtered, the body must be prepared to take action and appropriate behavior must be launched – all within a fraction of time. In terms of survival of a species (Darwin, 1859), the evolution of an efficient threat detection system makes sense. It has been argued that automatic, quick evaluation of a situation and activation of an organism to fight or flee increases its survival and consequently the likelihood of reproduction (compare: LeDoux, 1996; Öhman, 1993; Öhman & Soares, 1993). Geary (2007; Geary & Huffman, 2002) suggested that selective pressure must have led to the evolution of a certain "motivation to control". He sees such a "motivation" reflected in a kind of biased processing for survival related cues and a desire to modify environmental circumstances in order to enhance chances of survival. Specifically, it has been suggested (Öhman, Dimberg, & Öst, 1985; Öhman & Mineka, 2001; Seligman, 1971) that some biological threats have evolved to be processed quicker than others, because they once were life-threatening in human ancestry. Here, one could think of e.g., spiders, heights, predators, snakes, and interestingly enough, facial expressions. This last one may appear striking, but it has been supposed that facial expressions are highly communicative (Haxby, Hoffman, & Gobbini, 2000; Öhman, 2002; Öhman, Flykt, & Esteves, 2001; Öhman & Mineka, 2001). Öhman (1985) and colleagues suggested that an enhanced detection of angry faces is relevant for an individual in a group to

show submissive behavior if demanded. By doing so an individual sustains group structure and one's own membership. In the same line, ignorance of an emotional appeal might have lead to disrupted social group coherence (and still does) and might have led to rejection from the group. Taken even further, survival does also imply reproduction (Darwin, 1859). Ignorance of cues for alliances/mating or signals of threat can both hamper survival (Gilbert, 2001; Sapolsky, 2004). Thus, automated attention for e.g., a smile could be evolutionarily relevant when displayed by a member of the opposite sex, while an angry face may imply more danger when depicted by a member of the same gender (compare: Becker, Kenrick, Neuberg, Blackwell, & Smith, 2007).

Baron-Cohen (1995; but compare also: Emery, 2000) supposed that the interplay of neurological structures allowing eye gaze detection, in combination with the automated recognition of emotional expressions have a distinct communicative value. Someone looking fearful *at me* seems to be afraid of me, while he or she would be afraid of something *behind me* if not directly looking at me. In the latter case, it might be crucial, in terms of survival, to turn around quickly and find out myself. Here, eye gaze or gaze direction have the capacity to communicate the direction of threat, but also intentions. The capability to extract intentions and direction of attention of someone's eyes, and the facial expressions of another individual enhances, once more, survival. Fridlund (1994) investigated the evolutionary relevance of a facial expression as a whole. He assumed that displaying for instance, an angry face might have evolved as means to spare an individual from "costly" fighting beforehand. At the same time, an attentional bias for the quick detection of angry faces in an observer of such a display might keep one from dangerous, tedious defense:

> "Millions of years ago, if you crossed my turf, I might bite your head off [at some risk to me, if you decided to retaliate]. If you had advance warning, you might escape death through retreat or protective defense, and we'd both survive.

> But you'd need cues to retreat or protect. I'd have to give them, and you'd have to notice them. Here's the scenario: because of a lucky gene, I adventitiously bared one tooth for ½ second before I pounced. Your lucky gene made you look at my head. I bared my tooth, and you looked in the right place, not because I wanted to display my feelings, or because you wanted to see how I felt. We both acted out of pure dumb genetic luck. That we survived our skirmish increases the chances that our lucky genes will proliferate, and that my odd tooth-baring and your odd vigilance for it will both disseminate in our progeny." (Fridlund, 1994; p. 76)

There is an evolutionary drawback, however: As an excessive use of "threat displays" undermines its trustworthiness and might provoke attacks after all. Hypervigilance for such displays, on the other hand, might keep someone from valuable, even necessary resources (Fridlund, 1994). Even though, this mechanism is much more complex than presented here, it serves as comprehensible analogy: If one is hypersensitive to socio-evaluative stress, one might retreat from any form of social contact, become isolated, and increasingly experience difficulty in fulfilling one's daily social needs.

In sum, in the history of evolution, not only missing the opportunity to find a mate, or provoking the contempt of one individual but especially provoking the rejection from a group must have been a major threat to survival. This might, even today, explain general stress-proneness in human beings when interacting in groups (Juth, Lundqvist, Karlsson, & Öhman, 2005). Thus, sensitivity to certain facial expressions that communicate individually relevant emotions of others, and a certain degree of social anxiety that steers one's actions in a social context is adaptive and favorable. Hypersensitivity to social threat and exaggerated social anxiety, though, are costly in evolutionary terms.

Nevertheless, results substantiating evolutionary “preparedness” (compare: Seligman, 1971) for particular threat stimuli is not as consistently found as suggested (e.g., Mayer, Merckelbach, de Jong, & Leeuw, 1999), though neuro-biological research has been successful in locating the core features of the fear system. Consistently, the amgygdala, a central sub-cortical brain structure, has been found to play a key role in emotion related processes, as anxiety is one. It appears as if two neural pathways are involved in the processing of fear: A quick, direct route via thalamus and amygdala, and a slower indirect route via thalamus, cortical regions, and amygdala (e.g., Mitchell et al., 2007; Vuilleumier, 2005). Along the former route, the perceptual information processing is rather rudimentary: Based on several key features, analysis of the emotional relevance of a stimulus takes place quickly, and if necessary preparatory, reflexive behavior patterns are initiated. Via the latter route, a more thorough analysis takes place in the cortex. Here, not only threat cues but also environment cues, earlier experiences and knowledge gained over previous experiences are taken into consideration. Further action is guided by all available information, and continues or inhibits the behavior triggered via the quick route (LeDoux, 1996; Whalen et al., 1998). Both routes contribute to alerting and protecting an individual from harm when functioning properly.

But what, if the threat system is hypersensitive, if it alerts too early and overprotects the individual so that he or she consorts in a permanent state of fear and tension? What, if he or she overreacts to fairly controllable confrontations with supposed fear stimuli, in a way that, social, educational, or professional areas of functioning are impaired? Than one might fulfill the criteria of an anxiety disorder. Herein fears can have many different facets: they can be triggered by very specific cues as in specific phobia (e.g., arachnophobia: fear of spiders), or by a very broad variety as in generalized anxiety disorder.

The Diagnostic Statistical Manual of Psychiatric Disorders (DSM-IV; American Psychiatric Association, 2000 [APA]) differentiates seven anxiety disorders, with Social Anxiety Disorder (SAD; or Social Phobia) being the second from most prevalent one. In fact SAD is found to be the most prevalent mental disorder after major depression, substance dependency, and specific phobias, with lifetime

prevalence rates ranging from 7 to 13% (Hofmann & Bitran, 2007; Kessler, Stein, & Berglund, 1998; Vriends et al., 2007) .

People suffering from SAD are afraid to be evaluated negatively by, or to behave embarrassingly in the presence of others. Imagine yourself being constantly worried about how you come across when talking to other people. If individuals are afraid to be found boring or clumsy, their foremost fear is to be rejected and abandoned eventually. As a result, they may undergo, or develop marked and persistent fear in social or social performance situations in which scrutiny by others might be possible (for details see: APA, 2000). The age of onset reported for SAD, ranges between 12.0 and 16.6 years (Fehm, Pelissolo, Furmark, & Wittchen, 2005; Vriends et al., 2007). Earlier onset ages are associated with a more generalized and severe symptomatology. The disorder is more prevalent among females (Becker, Türke, Neumer, Soeder, & Margraf, 2002; Kessler et al., 1998). If untreated, SAD becomes increasingly associated with co-morbid mental problems such as depression, alcoholism, but also financial, social and occupational difficulties (Fehm et al., 2005; Stein, 2006). For obvious reasons, individuals with SAD generally take long, about four years, before contacting a health professional: They fear for instance to be despised for their complains by the clinician or not taken seriously. What makes matters even worse is the low proportion correctly diagnosed and treated patients: Only about 9% of the family physicians of social phobic patients realized that anxiety (in general) was the basis of the reported complaints by their patients (Wagner, Silove, Marnane, & Rouen, 2006).

In previous years several models have sought to describe the etiology of SAD. More recently research indicates that many factors play a role in the development of SAD: e.g., evolution (genetic vulnerability), personality (temperament as a child), parent-child interaction (e.g., overprotection), aversive/negative (childhood) experiences, deficits in social skills, avoidance behavior, and cognitive styles (e.g., negative interpretation of ambiguous social events; for overview see: Bitran & Barlow, 2004; Mathew & Ho, 2006; Rapee & Spence, 2004).

SAD is particularly characterized by a marked tendency to interpret (ambiguous) social events as negative and seeing negative cues as supporting evidence for the scrutiny at hand. Two influential models have attempted to explain these phenomena. In 1995, Clark and Wells presumed that individuals suffering from social anxiety disorder base their negative evaluations of social situations on a number of threatening assumptions (e.g., “If I am not an interesting interlocutor, they will not like me.”). Accordingly, social cues are interpreted in a tendentiously negative way confirming their fears (Figure 1.1). Their attention moves inwards on bodily anxiety symptoms, and on imaginations of themselves “messing up”, instantiating anxiety concepts in the present and for future situations.

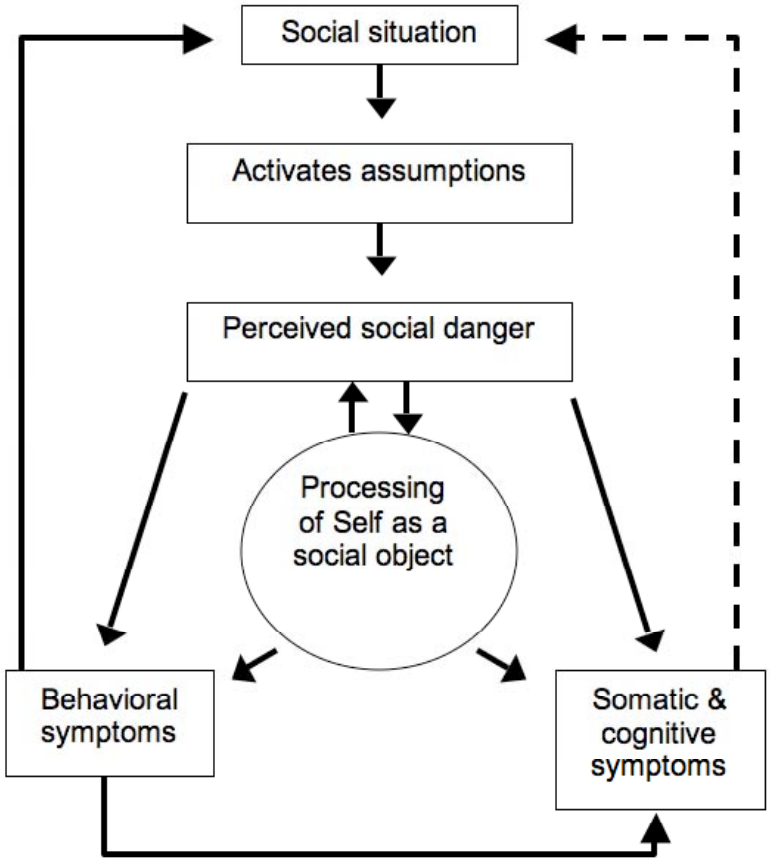


**Figure 1.1** *Model reprinted from Clark and Wells (1995).*

Similarly, Rapee and Heimberg (1997; Figure 1.2) associated a cognitive preoccupation with social threat as a maintaining factor in the etiology of social anxiety. In contrast to the suppositions of Clark and Wells (1995), they suggested a

vigilance to and focus on more external cues of threat by the anxious individual. Their model additionally implies that selective attention for signals representing potentially negative social evaluation might also include (ambiguous) emotional facial expressions.

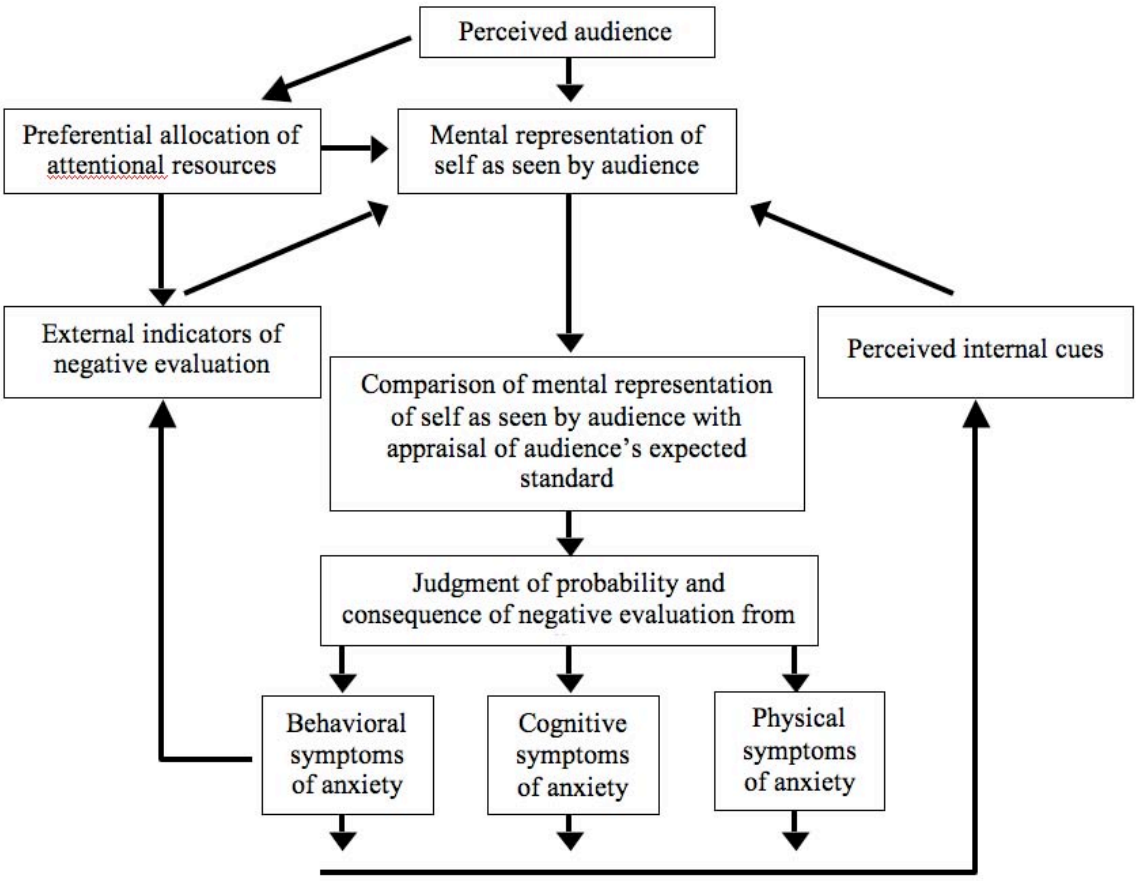


**Figure 1.2** *Model reprinted from Rapee and Heimberg (1997).*

Research exploring the validity of these cognitive models, has attempted to tackle various aspects of cognitive biases by investigating participants' reactions to socially threatening word fragments, (ambiguous) words, or text vignettes describing social scenarios, to-be-rated video fragments of social interactions, confederate feedback, or emotional and neutral face stimuli. When participants pay attention to, rate, or interpret (outcomes of) written ambiguous social situations, results frequently indicate that social anxiety might be associated with increased attention to negative or threatening information (Pishyar, Harris, & Menzies, 2004; Vassilopoulos, 2005),

and a negative interpretation style (Amir, Foa, & Coles, 1998b; Brendle & Wenzel, 2004; Huppert, Foa, Furr, Filip, & Mathews, 2003; Stopa & Clark, 2000; Voncken, Bögels, & de Vries, 2003). Negative interpretation- and judgment biases of social scenarios are believed to be prominent candidates for dysfunctional information processes in social phobic patients (Foa, Franklin, & Kozak, 2001; Mathews & Mackintosh, 2000).

There is less coherent evidence of such a bias when participants have to react to, evaluate, or identify facial expressions, a main ingredient of social interaction (for overview see Table 1.1). This is surprising, when considering that facial (emotional) expressions are reputed to be of marked evolutionary value (Haxby et al., 2000; Öhman, 2002; Öhman, Flykt et al., 2001; Öhman & Mineka, 2001) especially for social interactions. In fact, processing of emotional faces is believed to be "hardwired" to specific brain areas for quick identification/recognition (e.g., Haxby et al., 2000; Herrmann, Ehlis, Muehlberger, & Fallgatter, 2005; Vuilleumier, 2002, 2005). As stated above, this speeded processing is thought to have evolved in order to facilitate, under more, detection of anger in an opponent and protect an individual from harm. Specifically, an expression of for example sympathy, surprise, or anger, but also a neutral/ambiguous face might be potentially threatening for a person suffering from SAD because such expressions might be interpreted as reflecting rejection or might simply ask for interaction.

In sum, while evaluation biases in social anxiety are consistently found with word related material, compatible results with facial expression are scarce. In this thesis distraction by, (automatic) responses to, and recognition and direct evaluations of emotional and neutral faces are being assessed and are interpreted in relation to degree of social anxiety in non-clinical populations. The employment of socially anxious individuals rather than participants suffering from SAD must be seen as an analogy. While the first are much easier to recruit in a university environment, recruitment of the latter demands much more time and resources. We felt that results from socially anxious but not diagnosed participants can contribute largely to the understanding of social phobia.

Goal of the present thesis is to shed more light on afore mentioned inconsistencies of facial expression research in social anxiety. By doing so we strive to contribute to the development of a theoretical outline that helps understand the role and the nature of cognitive distortions when socially anxious individuals are confronted with emotional expressions, and eventually use our comprehension to develop improved treatment modules and help reduce the suffering of patients with this debilitating disorder. To achieve this goal, the following line of research will be put forward and the following research-questions will be asked:

First, we start with a more general investigation attempting to replicate findings showing that supposedly evolutionarily relevant threat cues, namely pictures of spiders and of angry faces, have the potential to draw and especially hold attention in a way that other reflexive attentional processes are undermined. We will investigate whether both types of stimuli trigger attentional vigilance and enhanced dwelling (disrupted disengagement) in a normal population as would be expected if evolutionarily relevant. Subsequently, we will investigate, whether the same processes are more pronounced in a population with fear for such stimuli (spider fearful and high socially anxious individuals).

Second, phenomena imputed to disrupted disengagement can also be attributed to a narrowing of attention when one is confronted with threatening material in the attentional field. By means of a flanker paradigm we will explore if threatening stimuli do indeed narrow the attentional field and thus restrict the influence of task irrelevant flanking stimuli. Additionally we are interested if such an effect is enhanced with high degrees of social anxiety and as such contribute to the maintenance of anxiety symptoms.

Third, attentional vigilance for a threatening face cannot only manifest itself in quick detection of a “full-blown” facial expression. In fact, it would be plausible to assume that socially anxious individuals are also particularly good in detecting a threatening emotion very rapidly and identify the developing expression correctly before the entire expression has been seen.

Fourth, to answer the question if not only covert attentional processes but, additionally, overt attention is affected by certain types of facial expression, we will

record the eye movement of participants while observing a matrix of faces (facial crowd) with different ratios of two intermixed expressions. Additionally, we will explore if the eye movements can predict subjective evaluations of the crowds by the participants and if social anxiety plays a dominant role in it.

Fifth, when social anxiety is characterized by fear for social situations and communication, looking for negative ratings of facial crowds may not be sensitive enough to tap into and explain the cognitive processes of the disorder. Therefore, we will investigate if automatic behavior patterns, such as approach and avoidance reactions, differ between socially anxious individuals and non-anxious individuals when confronted with emotional facial crowds.

Finally, after examining different facets of cognitive biases and automatic behavior patterns, the sequence of cause and effect needs to be addressed. We will investigate whether in a normal population an induced cognitive bias, as previously observed in socially phobic individuals, brings about reflexive approach-avoidance tendencies that are similar to those of socially anxious individuals.

**Table 1.1** *Review of literature investigating attentional biases and evaluative biases concerning facial expressions in social anxiety. Columns reflect author(s) and reference year, participant specification, short summary of the method, kind of stimuli, and results concerning biases and social anxiety*

| Author(s) | Year | Participants | Method | Face & other stimuli | Results |
|---|---|---|---|---|---|
| Abrams | 1999 | SA<br>NC | With(out) SES: Emotion categorization task | Different intensities: Anger, fear, sad (?) | SA: increased errors in decoding low-intensity facial cues of emotion, under SES. Errors involve mislabeling of fearful expressions as sad or angry. Results might be limited to women only. |
| Amir, Klumpp, Elias et al. | 2005 | SP<br>NC | fMRI, valence rating | Disgust, neutral | SP: faster in rating disgust and more negative in rating neutral faces |
| Benoit, McNally, Rapee, Gamble, & Wiseman | 2007 | A?ch<br>A?a<br>NC | Emotional stroop | Anger, disgust, happy, neutral | General attentional capture in anxious participants. No expression specific bias |
| Bradley, Mogg, & Millar | 2000 | [SA<br>NA] | Visual probe task, eye movement | Angry (threat), happy, neutral, sad | SA: No findings for RT data. Preference to shift eye gaze to negative faces |
| Chen, Ehlers, Clark, & Mansell | 2002 | SP<br>NC | Visual probe task | Angry, disgust, fear, happy, neutral, sadness & household objects | SP: Attention away from all faces |
| Coles | 2004 | SP<br>NC | Recognition Task | Critical, accepting | SP: No bias found<br>NC: Response bias for accepting faces |
| Coles & Heimberg | 2005 | SP<br>NC | Judge critical/accepting attitude, recognition task | Critical, accepting | SP: Recognized higher proportion critical faces.<br>NC: Response bias for accepting faces. No group differences in accuracy of memory |
| Creswell, Woolgar, Cooper et al. | 2008 | iChSP<br>NC | Preferential looking task | Non-faces, emotional faces with different intensities & gaze directions: Angry, fearful, happy | iChSP: Avoidance of high intensive fearful faces |
| de Jong & Martens | 2007 | SA<br>NC | Rapid serial visual presentation | Angry, neutral | Anger superiority found, but not pronounced in SA |
| Dimberg & Thunberg | 2007 | SpA<br>NC | Face EMG, SCR, HR, pleasantness rating, rating how much expression resembled basic emotions | Angry, happy | SpA: Rated angry as more unpleasant and resembling disgust. Happy was rated as more pleasant |
| Douilliez & Philippot | 2003 | SA<br>NC | Evaluate threat value | Images, words, faces: Negative, neutral, positive | No group differences found |

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| Eastwood, Smilek, Oakman et al. | 2005 | SP<br>PD<br>OCD<br>NC | Visual search Task | Schematic faces: Negative, neutral, positive | SP & PD: Attentional bias towards negative faces |
| Garner, Mogg, & Bradley | 2006 a | SA<br>NC | Illusory correlation paradigm | Angry, happy, neutral | SA: lack positive expectancy bias on-line. more negative reports off-line |
| Garner, Mogg, & Bradley | 2006 b | SA<br>NC | With(out) SES: Visual probe task & eye movement | Angry, happy, neutral & objects | SA: No SES - preference of neutral faces not objects. SES - preference objects not neutral faces. Vigilance-avoidance pattern for emotional faces |
| Gilboa-Schechtman, Foa, & Amir | 1999 | SP<br>NC | Visual search task | Angry, disgust, happy, neutral | SP: Anger superiority effect in SP. More distraction by happy and angry distractors than by neutral ones. Faster when detecting anger than disgust |
| Gilboa-Schechtman, Presburger, Marom, & Hermesh | 2005 | SP+D<br>SP-D<br>NC | Ratings and decision latencies when evaluating mixed facial displays | Matrices of angry, happy, neutral (to produce varying degrees of approval) | All SP: Evaluated predominantly disproving displays more negative and processed such stimuli faster |
| Hermann, Ziegler, Birbaumer, & Flor | 2002 | SP<br>NC | Aversion conditioning, subjective evaluations | Neutral | SP: Enhanced UCS- expectation also for UCS+. Elevated subjective arousal |
| Heuer, Rinck, & Becker | 2007 | SA<br>NC | Approach-avoidance task, face rating | Angry, happy, neutral & non-face puzzles | SA: Avoidance tendencies of angry and happy. No rating differences |
| Horley, Williams, Gonsalvez, & Gordon | 2003 | SP<br>NC | Eye movement | Happy, neutral, sad | SP: Longer scanpath with fewer and shorter fixations (avoidance) of salient facial features such as eyes, nose, mouth - especially when observing sad faces |
| Horley, Williams, Gonsalvez, & Gordon | 2004 | SP<br>NC | Eye movement | Angry, happy, neutral, sad | SP: Longer scanpath with fewer and shorter fixations (avoidance) of salient facial features such as eyes, nose, mouth - especially when observing angry faces |
| Joormann & Gotlib | 2006 | MDD<br>SP<br>NC | Emotion categorization in morphed film paradigm | Angry, happy, sad | SP: Needed less intensity to identify angry faces than happy and sad |
| Juth, Lundqvist, Karlson, & Öhman | 2005 | SA<br>NC | With SES (Experiment 2): Visual search | Directed/averted real/schematic faces: Angry, happy, neutral | SA: no effect with real faces. With schematic faces: enhanced anger superiority effect, but only in accuracy data, with emotional distractors, and with SES |
| Kolassa & Miltner | 2006 | SP<br>NC | Gender & emotion categorization, EEG, HR | Angry, happy, neutral | No bias found in behavioral data |
| Kolassa, Kolassa, Musial, & Miltner | 2007 | SP<br>SpP<br>NC | Pilot study - Pleasantness rating. Main study - Emotional stroop, emotion categorization, EEG, HR | Schematic faces: Angry, happy, neutral | SP: Pilot study - no differences in ratings. Main study - No bias found in behavioral data |

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|---|---|---|---|---|---|
| Krasnoperova | 1999 | MDD<br>CA<br>NC | Information processing paradigms (?) | Angry, happy, sad | No attentional bias found. Deficits of both clinical groups in accurately labeling the depicted expressions |
| Lissek, Levenson, Biggs et al. | 2008 | SP<br>NC | Pleasantness rating pre/post fear conditioning | Angry, happy, neutral | SP: No differences on ratings before but after conditioning for perceived pleasantness of angry faces |
| Lundh & Öst | 1996 a | SP<br>NC | Judgment of contact, recognition task | Neutral (?) | SP: Generally expected less good contact with depicted person. No group differences on recognition |
| Lundh & Öst | 1996 b | SP<br>NC | Judge critical/accepting attitude, recognition task | Neutral (?) | SP: Recognized higher proportion critical faces.<br>NC: Response bias for accepting faces. No group differences in accuracy of memory |
| MacKinnon & MacIntyre | 2007 | SpA<br>NC | Approval ratings of audiences during speech | Matrices of angry, happy, neutral (to produce varying degrees of approval) | HPsA: Rated all audiences as more disapproving |
| Maieritsch & Walter | 2003 | SA<br>NC | Visual probe task pre/post public speaking course | Negative, neutral, positive (?) | SA: Attentional bias towards negative faces |
| Mansell, Clark, Ehlers, & Chen | 1999 | SA<br>NC | With(out) SES: Visual probe task | Negative, neutral, positive & household objects | SA: Attentional bias away of emotional faces under conditions of SES |
| Matsumoto | 2007 | SA(?)<br>NC(?) | Visual search | Angry, happy, neutral | Divergence of search efficacy in Angry/neutral crowds depending on degree of social anxiety |
| McClure & Nowicki | 2001 | [SAch<br>NCch] | Identification of emotion in visual & vocal non-verbal material | Different intensities: Angry, fear, happy, sad | SA: Correlated with accuracy deficits in identification of vocal stimuli but not of facial expressions |
| Melfsen & Florin | 2002 | SAch<br>NC | Emotion categorization into: Negative, neutral, positive & rating how confident about choice | Angry, disgust, happy, neutral, sad | SAch: Categorized more often as emotions when expression was neutral. Longer RTs |
| Merckelbach, van Hout, van den Hout, & Mersch | 1989 | SP<br>NC | SCR, eyeblink, pleasantness ratings | Angry, happy & neutral objects | No group differences in ratings found |
| Meyer | 2005 | STyp<br>SA<br>NC | Emotion categorization task | (?) | SA: No impairment found |
| Mogg & Bradley | 2002 | [TA<br>NC] | Visual probe task | Masked presentation: Angry, happy, neutral | Attentional bias towards threat face is modulated by social anxiety and social avoidance – not trait anxiety |
| Mogg, Philippot, & Bradley | 2004 | SP<br>NC | Visual probe task | Stimulus durations (short/long): Angry, happy, neutral | SP: Enhanced vigilance to angry faces with short stimulus duration only |

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|---|---|---|---|---|---|
| Mohlman, Carmin, & Price | 2007 | SP<br>NC | With(out) SES: Card sorting | Different intensities: Angry, neutral | SP: SES - greater accuracy when sorting angry face cards. Significantly more misclassifications of neutral face cards as angry.<br>NC: Sorted neutral face cards more accurate and misclassified angry face cards more as neutral |
| Montagne, Schutters, Westenberg et al. | 2006 | SP<br>NC | Emotion categorization task | Different intensities: Angry, disgust, fear, happy, sad, surprise | SP: Need higher intensities when recognizing anger and disgust |
| Moser, Huppert, Duval & Simons | 2008 | SA<br>NC | Flanker Task, EEG | Angry, disgust, happy, surprise | No group differences (attentional bias) in behavioral data |
| Mullins & Duke | 2004 | SA<br>NC | With(out) SES: Emotion categorization task | Different intensities: Angry, fear, happy, sad | SA: SES - faster responses to high intensity angry expressions. Additionally, on highest level of state anxiety response times to high intensity expressions, in general, and angry expressions, in particular, dropped significantly. No SES - slower responses to high intensity fearful expressions and low intensity expressions of sadness and anger. No accuracy deficits found. |
| Philippot & Douilliez | 2005 | SP<br>AC<br>NC | Emotion categorization task | Different intensities: Angry, disgust, fear, happy, sad | No group differences in accuracy nor RTs |
| Pineles & Mineka | 2005 | SA<br>NC | With(out) SES: Visual probe task | Threat (?), happy, neutral & visualized heart rates/sound waves | No group differences (attentional bias) with regard to threat faces |
| Pishyar, Harris, & Menzies | 2004 | SA<br>NC | Emotion categorization task, estimation of cost of interacting | Negative, neutral, positive | SA: Attentional bias to negative faces<br>NC: Attentional bias to positive faces |
| Rossignol, Anselme, Vermeulen, Philippot, & Campanella | 2007 | SA<br>NC | Emotion categorization task, EEG | Different intensities: anger, disgust (?) | SA: No facilitation to disengage from disgust when they have to detect angry faces<br>NC: Facilitation to disengage from disgust when identifying angry face |
| Schofield, Coles, & Gibb | 2007 | SA<br>NC | Recognition task, estimation of cost of interacting | Different intensities & duration: Disgust, happy, neutral | SA: No recognition bias but higher cost estimates for disgust |
| Silvia, Allan, Beauchamp, Maschauer, & Workman | 2006 | SA<br>NC | Emotion categorization task | Angry, happy, sad | SA: Recognition of happy takes longer |
| Simonian, Beidel, Turner, Berkes, & Long | 2001 | SPch<br>NCch | Emotion categorization task | Angry, disgust, fear, happy, sad, surprise, | SPch: More errors especially in labeling happiness, sadness, and disgust |

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|---|---|---|---|---|---|
| Sposari & Rapee | 2007 | SP<br>NC | With SES: Visual probe task | Angry, disgust, fear, happy, neutral, sad & household objects | SP: Vigilance to (all) faces not household objects |
| Stirling, L. J., T. C. Eley, et al. | 2006 | SAch<br>NC | Visual probe task | Angry, happy, fear, neutral | SAch: Avoidance of angry and fearful faces |
| Van Hout, Merckelbach, & Mersch | 1991 | hSP<br>lSP | Interference of emotional expressions on primary counting task, valence rating | Angry, happy, neutral | No group differences on counting performance or subjective valence ratings |
| White | 2002 | SP<br>STyp<br>NC | Pre-pulse inhibition, affect modulation, startle blink, SCR, emotion & feature categorization | Angry, happy, neutral | SP: Attentional bias to emotional faces. Impaired emotion detection in females |
| Winton, Clark, & Edelmann | 1995 | SA<br>NC | Emotion categorization task, rating overall emotion of videos | Negative, neutral | SP: Interpretation of others' expression as negative. No enhanced ability to discriminate emotional states in others |
| Yoon, K. L. | 2006 | SA<br>NC | With(out) SES: Valence judgment | Emotional faces (?) and neutral | Study1 – SA: general negative interpretation of emotional stimuli but no interpretation bias of neutral faces.<br>Study2b - SA: Negative interpretation of neutral faces with and without SES. NC only with SES |
| Yoon, Fitzgerald, Angstadt, McCarron, & Phan | 2007 | SP<br>NC | fMRI, emotion categorization task | Different intensities: Angry, disgust, fear, happy, neutral, sad | No group differences in behavioral data |
| Yoon & Zinbarg | 2007 | SA<br>NC | Priming | Angry, disgust, happy, neutral | SA: Negative interpretation of neutral faces |

*Note.* The reported references have been obtained via PsychInfo and Medline, based on the following search terms in abstract and title: anxi* (covering anxious, anxiety), emotion* (covering emotion, emotional, emotionally), expression, fac* (covering facial, face), non-verbal, nonverbal, phobi* (covering phobia, phobic), social* (covering social, socially). Unfortunately, not all relevant information could be obtained from all articles. This is due to limited access to full-texts of some sources. Here, information could only be refined from the abstracts. In other cases even though the full-text version was available, terminology remained vague (e.g., negative, threatening, critical facial expressions). Questionmarks "(?)" indicate when detailed information is missing. Additionally, not all studies were primarily concerned with the measurement of interpretation or attentional biases via behavioral tasks. These tasks were nevertheless employed and reported in some studies while mainly physiological markers where assessed.

Abreviations (organized per column, alphabetically)

**Participants:**

| | |
|---|---|
| [] | correlational study, social anxiety measured but not prescreened upon |
| A?a | anxious adolescents - not known whether social anxiety was assessed |
| A?ch | anxious children - not known whether social anxiety was assessed |
| AC | anxious controls (excluding social phobia) |
| CA | clinically anxious - not known whether participants' social anxiety was assessed |
| HPsA | high public speaking anxious |
| hSP | high socially phobic |
| iChSP | indexed children of a social phobic mother |
| lSP | low socially phobic |
| MDD | with major depressive disorder |
| NC | normal controls, matched with participant group of particular study |
| OCD | with obsessive-compulsive disorder |
| PD | with panic disorder |
| SA | socially anxious |
| SAch | socially anxious children |
| SP | with social phobia |
| SpA | with speech anxiety |
| SPch | socially phobic children |
| SP+D | socially phobic with comorbid depression |
| SP-D | socially phobic without comorbid depression |
| SpP | with spider phobia |
| STyp | schizotypic personality |
| TA | trait anxious |

**Methods:**

| | |
|---|---|
| EEG | electroencephalography |
| EMG | electromyography (of particular face muscles) |
| fMRI | functional magnetic resonance imaging |
| HR | heart rate |
| SCR | skin conductance response |
| SES | social evaluative stress |

## Inhibition of return (IOR) and emotional cues

In Chapter 2, the influence of emotional stimuli on reflexive attentional processes is investigated. Usually, a target is detected more quickly when the location where it is about to occur is previously cued (reflexive orienting), then when it is not cued or when the cue is wrong. With long cue-target stimulus onset asynchronies, though, response latencies become longer when the target is correctly cued (Posner, 1980, 1990). This phenomenon, called Inhibition of return (IOR), is thought to facilitate the processing/scanning of novel over previously scanned visual loci, promoting more efficacy of the attentional system (Klein & MacInnes, 1999; Lupianez, Klein, & Bartolomeo, 2006). On the other hand, it is supposed that an increased threat sensitivity or threat appraisal as observed in anxiety disorders, can bias reflexive orienting predominantly towards threatening stimuli (hypervigilance: e.g., Eysenck, 1992; Fox, Russo, Bowles, & Dutton, 2001; Mathews & MacLeod, 2005; Williams, Watts, MacLeod, & Mathews, 1988). When comparing both theoretical implications, IOR with those of hypervigilance for threat, they seem to contradict each other (compare: Theeuwes & Van der Stigchel, 2006): When the cue is biologically relevant and threatening, the IOR effect should be weakened. Cognitive theories of anxiety do indeed suppose that threatening, biologically relevant cues catch and hold attention and diminish the IOR effect, even if the location is already inspected (e.g., Fox, Russo, & Dutton, 2002).

In three experiments we tested the hypothesis that the emotional valence of cues (animals or facial expressions) influence the strength of the IOR effect in a probe detection task. To increase the degree of threat relevance, all materials were additionally tested in spider fearfuls, socially anxious, and non-anxious control participants.

## Distraction or facilitation in a flanker task

The assumption that threatening valid cues undermines IOR is based on the idea that individuals sensitive to those threats have difficulty disengaging their attention from the "threat location". Hence, the influence of an "attentional bias for novelty" diminishes. Disrupted disengagement however, can also be spawned by a narrowing of the attentional diameter in response to threatening stimuli. In 2003, Fenske and Eastwood employed Eriksen and Eriksen's flanker paradigm (1974) to investigate the role of attentional narrowing. Participants were asked to categorize the expression of centrally presented (emotional) target faces, while ignoring the faces (flankers) left and/or right of the target. Yet, flankers did influence task performance. Eriksen and Eriksen (1974) found that in general flankers similar to targets speeded target categorization (flanker-compatibility effect) as compared to differing flankers. Since threat is associated with attentional narrowing, Fenske and Eastwood (2003) found that attentional narrowing in reaction to a threatening target facilitated its categorization: Facilitating similar flankers and distracting dissimilar flankers fall beyond the attention boundaries and the flanker-compatibility effect is weakened when threatening targets have to be categorized. In an attempt to replicate their findings (Chapter 3), we used a comparable experimental setup but employed real facial expressions instead of schematic faces.

## The recognition of morphed emotions

Social anxiety might be characterized by biased mechanisms beyond extended dwelling on the location of threatening stimuli, increased distractibility, or attentional narrowing in response to facial expressions. It is possible that socially anxious individuals simply recognize threatening stimuli faster or believe to have detected the first signs of a negative facial expression (as suggested by Rappee and Heimberg, 1997). In the study described in Chapter 4, we examined this hypothesis. When observing the progressing of a face that gradually changes from neutral to emotional

(angry, neutral, happy, disgusted), socially anxious and non-anxious participants were instructed to stop the film whenever they recognize the expression. We registered the elapsed time and also the emotion participants believed to see developing during the film, and whether their guesses are correct. In a second task, high and low socially anxious participants watch the same morphed movies but are free to fast-forward or rewind the film to find the “onset-point” of the emotional expression and to see the full expression at the end of the film. Again the onset-point of the emotion, its name, and errors in naming the displayed emotion are recorded.

## The movement of eyes when observing a crowd

In Chapter 4 a new dimension has been added to the series of experiments: Conscious guessing of the developing emotional expression (restricted viewing) and naming of the emotion when finally completely displayed (free viewing). This has brought up the question how recognition and evaluation take place and whether overt attentional processes such as eye movements can predict them. Further, it is possible that single face stimuli are not ambiguous enough to leave much room for misinterpretation. It is thinkable that the presentation of a group of faces showing different emotional expressions simultaneously creates increased ambiguity to provoke negative evaluation. In fact, it is supposed that social interaction in groups is even more threatening for socially anxious individuals than one-on-one interaction (Gilboa-Schechtman, Presburger, Marom, & Hermesh, 2005). In Chapter 5, we therefore explored if social anxiety is related to negative evaluation of emotional crowds. Here, “crowds” are constructed, showing individuals with different ratios of two different facial expressions (happy-angry, or neutral-angry). The subjective ratings of how “friendly” the participants find the groups were compared between socially anxious and non-anxious control participants. To shed more light on the attentional processes involved, we also recorded the eye movements while participants observed the displays.

## Approach-avoidance tendencies and emotional crowds

Eye movement recording in Chapter 5 have revealed that social anxiety was related to shorter gaze durations at angry faces once they were fixated first. Additionally, SAs, as compared to NACs, had a tendency of fixating proportionally more angry faces than non-angry faces. It appears that negative evaluation of emotional faces might not so much be reflected in conscious evaluations, but rather in automatic behaviors such as eye movement. In Chapter 6, we specifically investigated if (biased) evaluation of facial expression is more clearly reflected in automatic behavior than in direct evaluation. If processing of emotional faces is indeed facilitated by neurological hardwiring, investigation of distracted covert attention by threat, or conscious ratings of facial expressions might not tap into the responsible cognitive mechanisms, or might not be sensitive enough to detect possible biases. Measurement of observable automatic or reflexive behavior impulses, on the other hand, might tap into these processes. To investigate this notion, we compare indirectly assessed, automatic evaluations in response to facial crowds, with direct, subjective evaluations of these facial crowds. In an adapted version of an Approach-Avoidance Task (AAT; Rinck & Becker, 2007), participants scoring high and low in social anxiety, could by means of a joystick “avoid” neutral-angry, or happy-angry face combinations (crowds) presented on a computer screen by quickly pushing them away, or “approach” them by pulling them closer. The underlying idea of this task is that human beings have a tendency to automatically approach pleasant stimuli while avoiding unpleasant or threatening ones (e.g., Chen & Bargh, 1999; Solarz, 1960), even when stimulus valence is not task relevant.

## Induced bias changes approach-avoidance tendencies

In Chapter 7, we extended the findings from Chapter 6. We have found that socially anxious individuals have a tendency to interpret ambiguous social situations as negative and impulsively react avoidant towards increasingly angry crowds. Therefore, we assume that an induced interpretative bias might be an analogy for

social anxiety and transfers to automatic approach-avoidance tendencies. In recent years, researchers have started to investigate the cause-effect-chain of biases in and symptoms of anxiety in more detail. It is still unclear if people are anxious to start with and hence develop a cognitive bias as a symptom. Or is it the other way around and have people adopted a cognitive style that eventually results in increased fear and symptoms of an anxiety disorder. To investigate the influence of biases on healthy human beings, new techniques have been developed, which allow the induction of cognitive biases in non-anxious participants (Cognitive Bias Modulation [CBM]; e.g., Mackintosh, Mathews, Yiend, Ridgeway, & Cook, 2006). The question remains, whether CBMs transfers/generalizes to measures estimating anxiety or anxiety-related behavior. Recently, it has been shown that a benign, four-session interpretation training (CBM-I) increased the number of positive interpretations of novel ambiguous events in highly trait anxious participants. Additionally, the degree of subjectively reported trait anxiety decreased after the training (Mathews, Ridgeway, Cook, & Yiend, 2007).

We have presented data in Chapter 6 showing that crowds with increasing emotional faces provoked automatic avoidance reactions in participants with elevated degrees of social anxiety. We wondered whether the same could be true when “normally anxious” participants are trained to negatively interpret ambiguous social situations. As in Chapter 6, an indirect Approach-Avoidance procedure is used to measure responses to emotional multi-facial displays (“crowds”) after the bias induction.

In Chapter 8, the findings of the six studies are summarized. Based on the presented studies we discuss our comprehension of the processing of (emotional) facial expressions in social anxiety disorder, as well as the implications for the research field.

Chapter 2

# Inhibition of Return is Unimpressed by Emotional Cues

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## Abstract

Inhibition of return (IOR) is a phenomenon observed when a target unexpectedly appears in the place of a preceding cue: With long cue-target stimulus onset asynchronies, reaction times are longer than for targets that appear in an alternative location. Cognitive theories of anxiety suppose that the IOR effect diminishes with threatening, biologically relevant cues because these catch and hold attention. To test this hypothesis, we conducted three experiments, in which emotional valence of cues (animals or facial expressions) had no influence on the strength of the IOR effect, neither in an unselected sample of students nor in highly spider fearful or socially anxious participants. Inhibition of return appears to be a robust effect, blind to cue valence.

## Introduction

According to theories of information processing, attention is a highly automated system striving to optimize quick and accurate perception of objects and changes in the visual field (Yantis, 1996). Several authors suppose that two distinguishable attentional systems control voluntary and automatic orienting (Norman & Shallice, 1986; Posner, 1980; Posner & Petersen, 1990). While the endogenous attentional system (voluntary orienting) appears to be located in the anterior brain areas, for example the anterior cingulated cortex, the exogenous attention system (reflexive orienting) is located in the parietal lobe, the pulvinar, and the superior colliculus (Roelofs, van Galen, Eling, Keijsers, & Hoogduin, 2003; for details see: Pardo, Pardo, Janet & Raichle, 1990; Peterson, Fox, Miezen, & Raichle, 1988). Moreover, it has been found that the reflexive attentional system exhibits a certain kind of "novelty bias", in that attention is allocated to specific locations only if it is likely that a new stimulus is going to appear in this location. If you are, for example, riding in your car and a ball rolls onto the street in front of you, your alertness increases because you expect a child running after the ball. The ball is a *cue* with some predictive value, that is, there is a high chance that the ball is followed by a child (a *target* of attention). Therefore, you voluntarily orient your head towards the location of where you first spotted the ball. If, after some elapsed time, no child has appeared to get the ball, its predictive value declines and so does the alertness to this specific cued location. It might even be so that it is more difficult now to redirect your attention to the "ball location" because you have already looked there and nothing happened. One has to be aware, though, that this simplified example refers to endogenous redirection of attention, a voluntary movement. Imagine now having made the experience sketched above several hundred times, each time with a child following the ball. It is very likely that the redirection of your attention to the ball has become automatized – reflexively triggered whenever a cue is detected. Taylor and Therrien (2005, p.1414) suppose that the cued position receives a "… hypothetical location-based inhibitory tag [which] marks the location as *visited*", and then inhibits subsequent return of attention to the same location. This phenomenon has been

termed *inhibition of return* of attention (compare: Klein & Taylor, 1994; Posner, Rafal, Choate, & Vaughan, 1985; Taylor & Klein, 1998, 2000).

Inhibition of return has been investigated mainly with a task employing two possible locations for cues and targets on a computer screen. In this task, a cue stimulus appears randomly in one of the two locations, disappears, and is then followed by a target, which appears either in the cued location (called a *valid* trial) or in the uncued location (*invalid* trial). If the target follows the cue quickly, people often show a faster reaction to targets on valid trials than on invalid ones, a phenomenon called *facilitation by cueing*. If there is a delay between cue onset and target onset, the pattern reverses, and *inhibition of return (IOR)* occurs. Posner and Cohen (1984) suggested that the temporal limit which separates facilitating cueing effects from IOR effects lies around an SOA of 300 ms (i.e., if the cue appears 300 ms earlier than the target), and Samuel and Kat (2003) found that the IOR effect is surprisingly stable between SOAs of 300 ms and 3300 ms. Moreover, inhibition of return of one's attention to a formerly cued location has biological and evolutionary implications. It prevents repeated scanning of irrelevant locations that have already been sampled, promoting more efficacy of the attentional system (Klein & MacInnes, 1999; Lupianez et al., 2006).

Independently of these findings, several authors have proposed that stimuli related to danger may be processed pre-attentively, and therefore particularly rapidly. In general, a pre-attentive analysis of stimuli makes evolutionary sense, for instance because fast detection of danger in the environment allows for faster reactions and hence, a higher chance of survival (Öhman, 1993; Öhman & Soares, 1993; LeDoux, 1996). Additionally, Mineka and Öhman (2002) assumed that mammals possess an evolved fear system, pre-programmed to rapidly detect specific, (formerly life-)threatening stimuli such as spiders, snakes, heights, and (socially) threatening facial expressions of others. Neurobiological research confirms that certain stimuli appear to have a kind of "biological hardwiring" that facilitates the identification and categorization of some stimuli above others: e.g., spiders and snakes (Öhman, Flykt et al., 2001; Öhman & Mineka, 2001), or emotional facial expressions (Haxby et al., 2000; Herrmann et al., 2005; Vuilleumier, 2002;

Vuilleumier & Pourtois, 2007). Therefore, reflexive orienting and the emotional relevance of these biologically or evolutionarily encumbered stimuli are of great interest in experimental psychopathology. For instance, it is supposed that an increased threat sensitivity or threat appraisal of anxiety patients biases their reflexive orienting to threatening stimuli, and by doing so initiates or maintains anxiety disorders (e.g., Eysenck, 1992; Fox, Russo, Bowles, & Dutton, 2001; Mathews & MacLeod, 2005; Williams, Watts, MacLeod, & Mathews, 1997). Hypervigilance for (biologically) threatening cues, the reflexive allocation of attention to threat and the aggravated disengagement of attention from threat in anxiety patients have been termed *attentional biases*.

If one combines the findings and theoretical explanations of IOR with those of attentional biases, it seems that inhibition of return and attentional biases for biologically relevant threat stimuli may contradict each other under certain circumstances (see also Theeuwes & van der Stigchel, 2006). In particular, the IOR effect should be weakened when the cue is biologically relevant and threatening. In this case, even if the threatening cue does not predict the location of the following target, it should catch and hold attention, such that targets appearing in its location will be advantaged rather than disadvantaged compared to targets appearing in another location. If this is indeed the case, the enhanced relevance of threatening cues in patients with an anxiety disorder may actually lead to a complete dissipation of the IOR effect. Indeed, there appears to be some evidence for this suggestion. Fox, Russo, & Dutton, (2002) concluded from their results that angry faces employed as invalid cues do indeed eliminate the IOR effect in highly trait anxious participants. In Experiment 2 of their study, they examined whether relevant emotional stimuli (schematic faces) would reduce the IOR effect, and whether the reduction would be more pronounced in high trait-anxious participants. Their results suggested a general reduction of the IOR effect following angry cues, but not neutral or smiling cues, in both high and low trait-anxious participants. In Experiment 3, all participants underwent a mood induction and a jumbled face replaced the smiling face in order to rule out low-level visual features as an explanation of the results. In this study, specific reductions of the IOR effect were found, however, for several reasons the

results have to be interpreted cautiously. First, jumbled faces produced the same IOR reduction as angry faces. Second, it appeared that the mood induction only worked for high trait-anxious individuals and not for the non-anxious controls. Consequently, group differences may be inflated by the unsuccessful anxiety induction in the non-anxious controls. Third, Fox et al. (2002) directed participants' attention to the fixation point again after cue presentation: "The cue was subsequently blanked out and 200 ms later the central cross was darkened for a further 300 ms. The initial fixation display was then presented for 160 ms and then the target was presented." (Fox et al., 2002; p. 367). This redirection of the participants' attention to the central fixation point between presentation of cue and target is not seen often, and its impact on the observed reaction times remains unclear. Nevertheless, the results contradict those of Taylor & Therrien (2005), who found that the IOR effect was not reduced by facial cues. None of these studies employed other biologically relevant cue stimuli, for instance threatening animals, and none studied the effects of these stimuli in groups differing in their specific fear of these stimuli.

Therefore, the purpose of the present study was to test the prediction of a reduced IOR effect following biologically relevant cues in different populations. To this end, we used versions of Posner's covert orienting paradigm (Posner, 1980). Posner distinguishes two types of orienting: *overt* with movement of head and/or eyes, and *covert* without moving head and eyes (Posner, 1980). In experiments employing this paradigm, participants are asked to react to a target presented anywhere in their visual field, while keeping their eyes focused on a central fixation cross. Before the appearance of the target, a cue appears either in the same location as the target (a valid cue) or in a different location (an invalid cue). In the experiments reported here, the stimulus onset asynchrony of cue and target was varied, as was the valence of the cue. In Experiment 1, drawings of a spider, a butterfly, and a cross (Experiment 1A) were used as cues, as well as pictures of angry, neutral, and smiling individuals (Experiment 1B). With neutral cues and longer SOAs (> 300 ms), cueing is generally thought to cause IOR, that is, facilitated target detection on invalid trials compared to valid ones. Therefore, we employed an SOA

of 550 ms for all cues. The critical question was whether in an unselected student sample, the IOR effect would be reduced for threatening, biologically relevant stimuli (spiders and angry faces), or for emotionally valenced stimuli in general (spiders, butterflies, angry and smiling faces), as opposed to neutral stimuli (crosses and neutral faces).

To find out whether the biologically relevant cues gain sufficient threat value when presented to highly fearful participants, the task containing spider, butterfly, and cross cues was repeated with selected samples of highly spider fearful participants versus non-fearful ones (Experiment 2). The prediction was that the IOR effect would generally be reduced by spider cues, and that spider fearfuls might not show any IOR effect at all after spider cues. In Experiment 3, the biologically relevant cues were again angry, neutral, and smiling facial expressions. It is supposed that an angry expression inflicts threat on human beings in general (Hansen & Hansen, 1988; Öhman, 2002; Öhman, Lundqvist, & Esteves, 2001) and especially so for socially anxious individuals (Lundh & Öst, 1996a, 1996b; Mogg & Bradley, 1999). Therefore, the same facial cues as in Experiment 1B were presented to selected samples of highly socially anxious versus non-anxious individuals. As in Experiment 1B, a general reduction of the IOR was predicted after cues showing angry facial expressions. Additionally, it was expected that in the highly socially anxious, the IOR might disappear altogether.

## Experiment 1: Emotional cues in an unselected sample

In Experiment 1, we investigated the influence of evolutionary relevant cues on the magnitude of the IOR. Angry emotional faces as well as spiders are supposed to have an evolutionary threat value to humans, therefore, both types of cues should reduce the IOR effect, such that participants do not react more quickly to invalidly cued targets than to validly cued ones. All participants completed the same set of questionnaires and the same two computerized experimental tasks (Part 1A: spider cues, Part 1B: facial cues).

*Experiment 1: General Methods*

*Participants.* An unselected sample of 54 students of the University of Nijmegen participated in the experiment (see Table 2.1). An experimental session contained two computer tasks and lasted for 40 minutes, for which participants received

**Table 2.1** *Mean scores (M) and standard deviations (SD) of age, gender, Fear of Spiders Questionnaire (FSQ), Spider Anxiety Screening (SAS-Spider), approach speed in the Behavior Assessment Task (BAT; cm/sec), Liebowitz Social Anxiety Scale (LSAS), trait version of the Spielberger State/Trait Anxiety Inventory (STAI-Trait), and Symptom Check List 90 (SCL-90) in Experiment 1 (n=54)*

| Variables | *M* | *SD* |
|---|---|---|
| Age (years) | 25.4 | 6.8 |
| Gender (% female) | 79.2 | |
| FSQ | 14.1 | 23.5 |
| SAS-Spider | 6.3 | 6.3 |
| BAT Speed | 54.5 | 25.3 |
| LSAS | 27.6 | 16.5 |
| STAI-Trait | 35.4 | 7.7 |
| SCL-90 | 129.8 | 28.4 |

payment of €4 or course credit. Due to registration errors and some missing values, not all data sets could be processed. Consequently, the composition of participants varied slightly between the two tasks and the questionnaires (see below).

*Procedure.* Before the two computer tasks 1A and 1B, participants filled in a general screening questionnaire for eyesight, handedness, education, and medication; the Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987; Mennin, Fresco, Heimberg, Schneier, Davies, & Liebowitz, 2002; Oakman, Van-Ameringen, Mancini, & Farvolden, 2003), the Spider Anxiety Screening (SAS; Rinck et al, 2002), the Fear of Spiders Questionnaire (FSQ; Syzmanski & O'Donohue, 1995), the state version of the State-Trait Anxiety Inventory (here: STAI-State1; Spielberger, Gorsuch & Lushene, 1970; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). The two computer tasks were conducted on Apple eMac computers with integrated 17"

monitors, operating at 700 MHz on Mac OS 10.2.8. Stimulus presentation and reaction time recording was controlled by the software RSVP 4.0.5 for Macintosh (Williams & Tarr, 1998). The order of the two tasks was counterbalanced across participants. After the two tasks, participants filled in the STAI-State again (here: STAI-State2), the Symptom Check List-90 (SCL-90; Derogatis, 1994), the Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock & Erbaugh, 1961), and the trait version of the STAI (STAI-Trait). Then they took part in a spider-related behavior assessment task (BAT): They had to approach a living tarantula in a

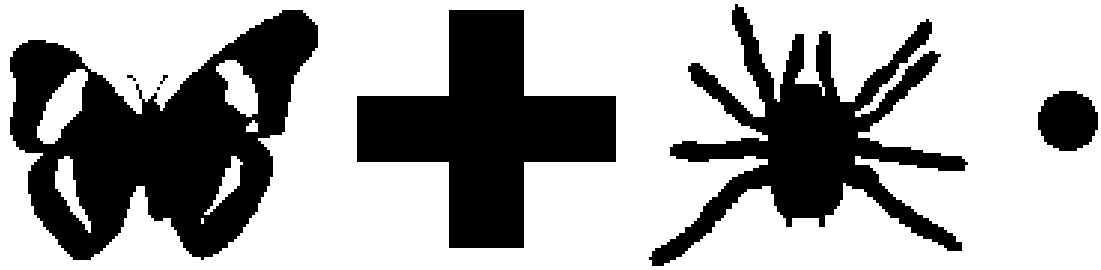

**Figure 2.1a** *Stimuli Task 1A and 2.*

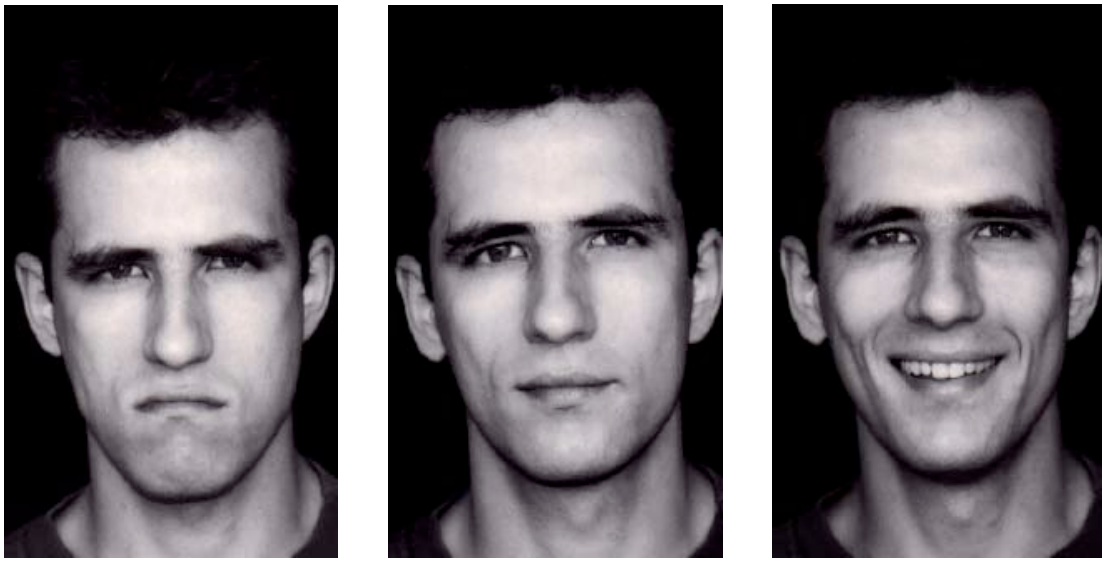

**Figure 2.1b** *Stimuli Task 1B and 3.*

terrarium as closely and as quickly as possible. The remaining distance to the terrarium and the time until participants stopped approaching was recorded.

Afterwards, participants were debriefed, thanked for their effort, and were paid or given course credit.

*Spider Task 1A: Methods*

*Materials.* Black-and-white drawings of a butterfly, a cross, and a spider were used as possible cues, and a black dot as the target. The cue pictures were approx. 110x100 pixels large, and the target dot was 22x22 pixels large. Two empty frames separated by a fixation cross served as possible locations for cues and targets. The two frames were 146x146 pixels large, and the distance between the fixation cross in the center of the screen and the centers of the frames to the left and right of it was 197 pixels (Figure 2.1a).

*Procedure.* Participants were seated about 50 cm from the computer monitor. The instructions were as follows: “On the screen, you will always see two empty frames with a fixation cross in between. The task will be easiest if you keep focusing on the fixation cross in the middle. First, in one of the frames a drawing (spider, butterfly, or cross) will be presented. After a while the drawing will disappear by itself. Then, a dot will be presented in one of the frames. You have to press the space bar as quickly as possible whenever you detect the dot in one of the frames. Following the key press, the next trial will start. In a third of the trials, no dot will appear, and you must not react. In this case, the program will continue automatically after 2 seconds”. Participants were given 54 trials to get acquainted to the procedure. In the main part of the task, participants finished 10 sets of 54 trials each. The total of 540 randomized experimental trials was divided equally into 20 trials for each combination of cue type, validness, and SOA. The sequence of each trial is depicted in Figure 2.2: A black fixation cross was displayed for 1000 ms in the center of the white screen with the two black square, empty frames to its left and to its right. Then, one of the cues (cross, spider, or butterfly) was shown for 100 ms in one of the two frames. In two thirds of the trials, the target dot appeared centered in one of the two frames with an SOA of 150, 250, or 550 ms (i.e., 50, 150, or 450 ms after the cue had disappeared). In one third of the trials, no cue appeared. After the participant’s

response or after 2 s, the next trial began (see Figure 2.2). The shorter SOAs of 150 and 250 ms were included to undermine the predictability of the cue-target time lag. These SOAs are not relevant here, therefore they will not be discussed any further[1].

*Design and analyses.* A 3 (cue type: spider, butterfly, cross) x 2 (cue validity: valid, invalid) factorial design was applied to the participants' median reaction times (RTs)

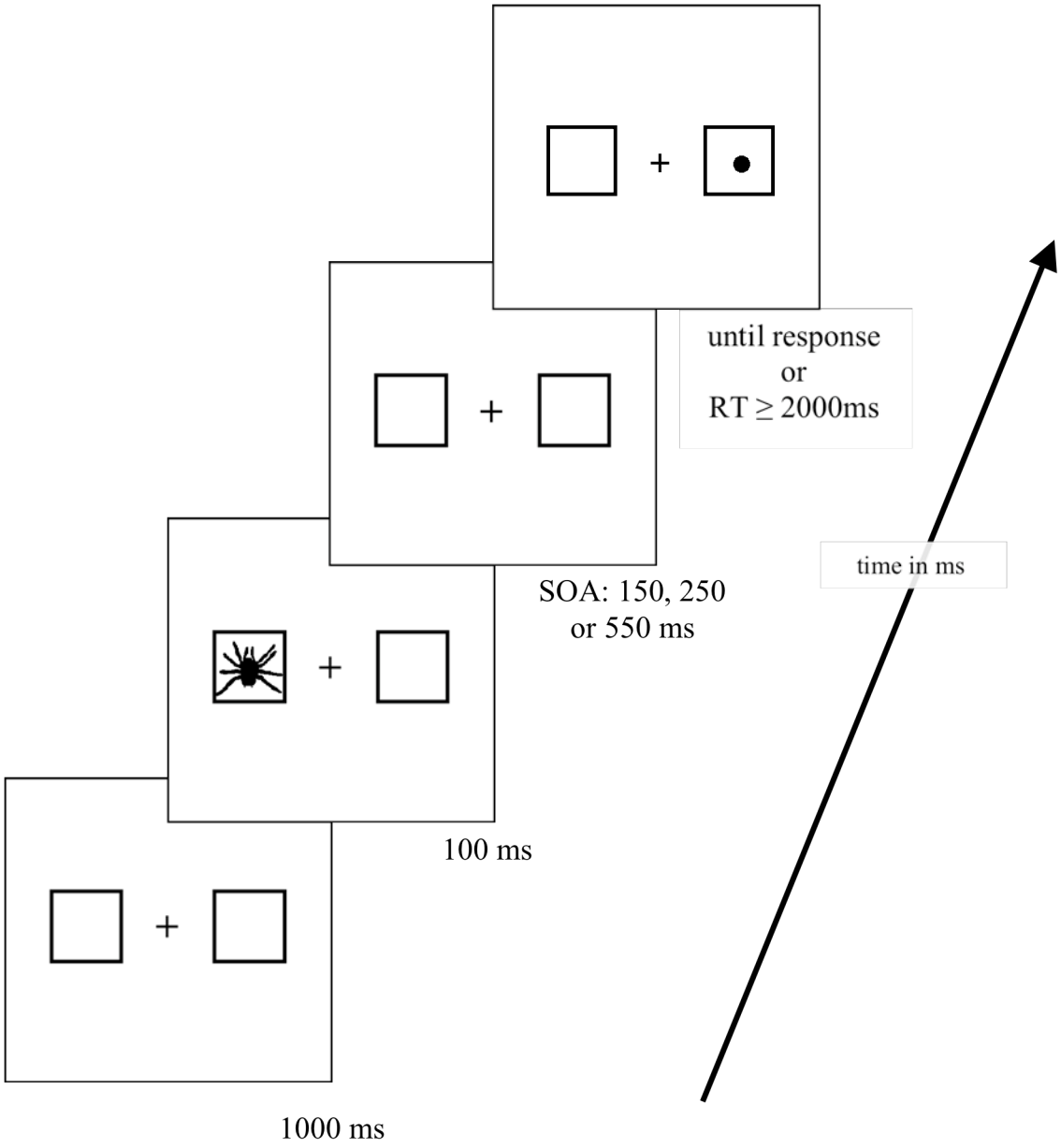


**Figure 2.2** *Example of experimental sequence Experiment 1A and 2.*

in response to dots appearing after an SOA of 550 ms. In addition, IOR effects were calculated by subtracting the median RTs of valid trials from the median RTs of the corresponding invalid trials: Facilitation of validly cued responses results in negative values, whereas positive values denote facilitation of invalidly cued responses, that is, inhibition of return. The participants' IOR effects were correlated with their fear of spiders, measured by SAS, FSQ, and the BAT. Whenever the assumption of sphericity was violated in one of the analyses reported below, more conservative tests were employed (Huynh-Feldt). An alpha level of .05 was used for all statistical tests. The same was true for the analyses of the following experiments. The following predictions were tested: First, responses to invalid trials should be faster than responses to valid trials (the IOR effect). Second, the IOR effect should be reduced after the biologically relevant threat cue, the spider. Third, the IOR effect after spider cues should be negatively correlated with fear of spiders, such that it disappears in participants who are highly spider fearful.

*Spider Task 1A: Results and Discussion*

Cue validity yielded the expected significant IOR effect on response latencies, $F(1,52) = 128.44$, MSE = 676.74, $p < .001$: In general, invalidly cued targets were detected more quickly than targets preceded by a valid cue (343 vs. 367 ms, see Table 2.2). This IOR effect was also significant for each cue analyzed separately, all $t(52) > 7.55$, $p < .001$. Stimulus type did not have a main effect, $F(2,104) < 1$,

**Table 2.2** *Mean RTs and standard deviations (in parentheses) in ms for each cue*

| | Experiment 1A (*n*=53): Cue type | | | Experiment 1B (*n*=54): Cue type | | |
|---|---|---|---|---|---|---|
| Cue validity | Angry | Neutral | Smile | Butterfly | Cross | Spider |
| VALID | 363 (36) | 359 (33) | 361 (38) | 380 (41) | 380 (36) | 379 (41) |
| INVALID | 342 (35) | 342 (40) | 342 (34) | 345 (41) | 346 (38) | 349 (38) |

MSE = 219.63; and it did not interact with cue validity, $F(2,104) = 1.13$, MSE = 215.74, n.s. The correlational analyses corroborated this result: Level of anxiety was not correlated with the IOR effects for any cue. While most measures of spider fear (FSQ, SAS, and BAT) correlated with each other, and all IOR effects correlated with each other, no significant correlation between a measure of fear and an IOR effect was observed (see Table 2.3).

The results of this task suggest that the IOR effect was unaffected by the biological relevance of the cues preceding the targets. In particular, spider cues did not reduce the IOR effect as compared to a neutral cross cue or positive butterfly cues. Furthermore, and in contrast to the results reported by (Fox et al., 2002), the magnitude of the IOR effect was not correlated with the individuals' level of fear, here fear of spiders, as measured by the SAS, the FSQ, or the BAT.

*Faces Task 1B: Methods*

Part 1B of Experiment 1 was designed as another test of the hypothesis that biologically relevant cues may reduce the IOR effect by attracting and holding attention at the location of a threatening cue. To this end, different types of relevant stimuli were used in Part 1B, namely, pictures of individuals with angry, neutral, or smiling facial expressions. These cues may be better suited for the reduction of the IOR effect than the simple animal drawings used in Part 1A.

**Table 2.3** *Correlations (Spearman's rho) between questionnaire scores, BAT speed (cm/sec), and IOR effects after spider, cross, and butterfly cues in Experiment 1A (n = 53)*

| | SAS | BAT Speed | Butterfly: valid-invalid | Cross: valid-invalid | Spider: valid-invalid |
|---|---|---|---|---|---|
| FSQ | .86** | -.25 | -.07 | .20 | .11 |
| SAS | | -.33* | -.05 | .24 | .17 |
| $BAT_{SPEED}$ | | | -.08 | -.26 | -.16 |
| Butterfly: valid-invalid | | | | .73** | .77** |
| Cross: valid-invalid | | | | | .77** |

*$p < .05$, two-tailed. **$p < .01$, two-tailed.

*Materials and procedure.* Black and white pictures of two individuals (one male, one female) were presented as cues. Each individual was shown on three pictures, showing an angry, neutral, or smiling facial expression (see Figure 2.1b). The pictures were 200x320 pixels large. The two location frames were adjusted to the new picture size, yielding 206x324 pixels, and the distance between the fixation cross in the center of the screen and the center of the frames to the left and right was 142 pixels. The fixation cross and the target dot remained unchanged. The procedure was basically the same as in Experiment 1A, except that the spider, cross, and butterfly cues were replaced by the facial cues showing an angry, neutral, or smiling expression (compare Figure 2.2).

*Design and analyses.* Again, a 3 (cue type: angry, neutral, smiling) x 2 (cue validity: valid, invalid) factorial design was applied to the participants' median RTs in response to dots appearing after an SOA of 550 ms. IOR effects were calculated as above, and they were correlated with social anxiety, as measured by the LSAS. The predictions for Part 1B of Experiment 1 were similar to those of the Part 1A: First, responses to invalid trials should be faster than responses to valid trials (the IOR effect). Second, the IOR effect should be reduced on trials with angry face cues. Third, the IOR effect after angry face cues should disappear with increasing degree of social anxiety.

*Faces Task 1B: Results and Discussion*

As before, cue validity had a significant IOR effect on response latencies, $F(1,53) = 106.62$, MSE = 283.88, $p < .001$: Invalidly cued targets were again detected more quickly than validly cued ones (346 vs. 373 ms, see Table 2.2). The IOR effect was significant for each type of facial cue, all $t(53) > 5.30$, $p < .001$. As before, stimulus type did not have a main effect, nor did it interact with cue validity, both $F(2,106) < 1$. Further, the IOR effects for different cues were not correlated with level of anxiety. While the pathology-related questionnaires (LSAS, STAI, SCL-90) showed significant intercorrelations, they did not show any significant relationship with the IOR effects (see Table 2.4). These results replicate those of Part 1A perfectly, in that

the IOR remained robust, regardless of which biologically relevant cue was used. Moreover, participants showed IOR effects that were unrelated to their level of social anxiety (assessed with the LSAS), trait anxiety (STAI), or general level of pathology (SCL-90). These results agree well with those of Taylor and Therrien (2005), but they are in contrast to those reported by Fox et al. (2002), who also employed emotional facial expressions as cues.

**Table 2.4** *Correlations (Spearman's rho) between questionnaire scores and IOR effects after angry, neutral, and smiling facial cues in Experiment 1B (n = 54)*

| | STAI-Trait | SCL-90 | Angry face | Neutral face | Smiling face |
|---|---|---|---|---|---|
| LSAS Sum | .53** | .55** | -.02 | -.07 | .06 |
| STAI-Trait | | .71** | -.07 | -.01 | .06 |
| SCL-90 | | | .03 | .03 | .16 |
| Angry face: valid-invalid | | | | .05 | .29* |
| Neutral face: valid-invalid | | | | | .00 |

*$p < .05$, two-tailed. **$p < .01$, two-tailed.

## Experiment 2: IOR for spiders in spider fearfuls

The first experiment was conducted following the assumption that some cues are biologically relevant, and to some degree threatening, for all humans. This should hold for spiders as well as for angry faces (Öhman, 2002; Öhman & Soares, 1993). However, the threat value of a cue should also be mediated by the person's individual fear of that particular cue. For instance, a spider should be more significant and more threatening for someone who is highly afraid of spiders, causing stronger

effects on this individual than on others (compare: Öhman, & Soares, 1993). Consequently, we may have been unable to detect a reduction of the IOR effect in the unselected sample of Experiment 1 because spiders were relevant, but hardly threatening to most participants in this sample. This may also explain the lack of correlations between IOR effects and questionnaires observed in the first experiment. Therefore, we repeated Part 1A of Experiment 1 in a selected sample of highly spider fearful individuals who were compared to a selected group of non-anxious control participants. In all other aspects, Experiment 2 was a direct replication of Experiment 1A. If threatening stimuli only reduce the IOR effect in highly fearful individuals, we should observe the reduction in the fearful group, but not in the control group.

## Methods

*Participants.* A selected sample of 23 highly spider fearful participants (SFs) and 24 matched non-anxious controls (NACs) participated in the experiment. All of them were first-year students enrolled at Dresden University of Technology, Germany (see Table 2.5). An experimental session lasted for 20 minutes, for which participants received payment of €2 or course credit.

*Materials, apparatus, and procedure.* These were identical to those of Experiment 1A, except for the following aspects of the procedure: During first year lectures, students were asked to fill in the SAS. They were invited to participate in the experiment if they scored below 6 points (NACs) or above 14 points (SFs) on the SAS. Upon arrival at the lab, participants filled in the SAS again and also the FSQ. If they scored below 12 or above 30 on the FSQ, they were admitted to further testing, and they completed the remaining questionnaires. The "Fragebogen zur Depressionsdiagnostik nach DSM-IV" (FDD; Kühner, 1997), which is the German version of the Inventory to Diagnose Depression (IDD; Zimmerman, Coryell, Corenthal, & Wilson, 1986), was added to the set of questionnaires. The rest of the procedure was identical to the one of Experiment 1A.

*Design and analyses.* Full combination of the within-subjects factors cue type (spider, butterfly, cross) and cue validity (valid, invalid) with the between-subjects factor anxiety group (SFs, NACs) yielded a 3x2x2 factorial design. The participants' median RTs in each of the six experimental conditions were used as dependent variables. The following predictions were tested: First, there should be an overall IOR effect, such that responses to invalid trials should be faster than responses to valid trials. Second, the IOR effect after spider cues should be reduced in the highly spider fearful participants.

**Table 2.5** *Means (M) and standard deviations (SD) of age, gender, and questionnaire scores for spider fearfuls (SFs) and non-anxious controls (NACs) in Experiment 2: Fear of Spiders Questionnaire (FSQ), Spider Anxiety Screening (SAS-Spider), trait version of the Spielberger State/Trait Anxiety Inventory (STAI-Trait), Fragebogen zur Depressionsdiagnostik (FDD), and Brief Symptom Inventory (BSI)*

| | SF (*n*=23) | | NAC (*n*=24) | |
|---|---|---|---|---|
| Variables | *M* | *SD* | *M* | *SD* |
| Age (years) | 21.0 | 1.4 | 21.4 | 2.0 |
| Gender (% female) | 87.0 | | 87.5 | |
| FSQ** | 61.1 | 17.7 | 2.0 | 2.7 |
| SAS-Spider** | 18.4 | 3.5 | 1.2 | 1.7 |
| STAI-Trait | 40.4 | 6.9 | 41.6 | 7.2 |
| FDD | 9.0 | 5.2 | 7.6 | 4.6 |
| BSI | 0.6 | 0.3 | 0.6 | 0.4 |

*$p < .05$, two-tailed. **$p < .01$, two-tailed.

*Results and Discussion*

As in Experiment 1A, a significant IOR effect was observed, $F(1,46) = 125.62$, MSE = 582.20, $p < .001$. As expected, invalidly cued targets were detected more quickly than validly cued ones (383 vs. 415 ms, see Table 2.6a). Again, the IOR effect was

also significant after each cue type tested separately, all $t(46) > 7.11$, $p < .001$. Moreover, level of spider fear had no effect whatsoever on RTs, indicated of by a lack of significant main effects or interactions of the between-subjects factor, all $F < 1.15$, n.s. Most importantly, after spider cues, both SFs and NACs showed significant IOR effects, $t(22) = 4.68$, $p < .001$ and $t(23) = 7.63$, $p < .001$, respectively, which did not vary in size, $F(1, 45) < 1$.

To summarize, besides the expected IOR effect, no other noteworthy effect was found. Thus, even in highly spider fearfuls, the IOR effect was not reduced by a spider cue. It seems that the spider did not catch and hold attention strongly enough

**Table 2.6** *Mean RTs and standard deviations (in parentheses) in ms*

*(a) Experiment 2: For butterfly, cross, and spider cues in spider fearfuls (SFs) and non-anxious controls (NACs)*

| | Group | | | | | |
|---|---|---|---|---|---|---|
| | SF (*n*=23) | | | NAC (*n*=24) | | |
| | Cue type | | | | | |
| Cue validity | Butterfly | Cross | Spider | Butterfly | Cross | Spider |
| VALID | 417 (43) | 422 (49) | 411 (36) | 413 (47) | 415 (46) | 410 (43) |
| INVALID | 380 (43) | 386 (50) | 384 (40) | 382 (34) | 387 (37) | 377 (35) |

*(b) Experiment 3: For angry, neutral, and smiling facial cues in Socially Anxious (SAs) and Non-Anxious Controls (NACs)*

| | Group | | | | | |
|---|---|---|---|---|---|---|
| | SAs (*n*=18) | | | NACs (*n*=22) | | |
| | Cue type | | | | | |
| Cue validity | Angry | Neutral | Smile | Angry | Neutral | Smile |
| VALID | 346 (32) | 345 (34) | 349 (34) | 360 (42) | 357 (37) | 354 (40) |
| INVALID | 337 (34) | 336 (34) | 339 (39) | 345 (43) | 348 (41) | 344 (37) |

to affect inhibition of return, even when the spider was threatening and highly relevant to the participants. This result replicates that of Experiment 1, in which a larger, but unselected sample was tested.

## Experiment 3: IOR for facial expressions in socially anxious individuals

Experiment 3 was designed as a follow-up to Experiment 1B. In Experiment 3, we also employed emotional facial expressions as cues, but instead of testing an unselected sample, we tested two extreme groups, as in Experiment 2. Similar to the reasoning of the second experiment, we predicted that the IOR-reducing effect of an angry face cue should be particularly strong in individuals who are highly socially anxious. This expectation is based on several findings suggesting that the attentional bias for threatening social stimuli is most pronounced in these highly anxious individuals (Fox et al., 2001; Mogg, Philippot, & Bradley, 2004). Thus, if pictures of emotional facial expressions are indeed more relevant stimuli than black-and-white drawings of spiders, and if emotional facial expressions are indeed most threatening to the socially anxious, a reduction of the IOR effect should be observed in Experiment 3. In particular, we predicted that after an angry face cue, individuals high in social anxiety should show a marked reduction of the IOR effect. To test this prediction, we repeated Part 1B of Experiment 1 in a selected sample of highly socially anxious individuals who were compared to a group of non-anxious control participants. In all other aspects, Experiment 3 was a direct replication of Experiment 1B.

## Methods

*Participants.* A selected sample of 18 highly socially anxious participants (SAs) and 22 matched non-anxious controls (NACs) participated in the experiment. All of them were students enrolled at Dresden University of Technology, Germany (see Table

2.7). An experimental session lasted for 20 minutes, for which participants received payment of €2 or course credit.

*Materials, apparatus, and procedure.* These were the same as in Experiment 1B, except for the following aspects: During lectures at Dresden University of Technology, students were asked to fill in the LSAS to screen their degree of social anxiety. They were invited to participate in the experiment if they scored below 14 points (NACs) or above 26 points (SAs). Upon arrival at the lab, they filled in the LSAS for a second time. If they scored within the same limits as on the screening

**Table 2.7** *Means (M) and standard deviations (SD) of age, gender, and questionnaire scores for socially anxious (SAs) and non-anxious controls (NACs) in Experiment 3: Liebowitz Social Anxiety Scale (LSAS), trait version of the Spielberger State/Trait Anxiety Inventory (STAI-Trait) and Fragebogen zur Depressionsdiagnostik (FDD)*

| | Group | | | |
|---|---|---|---|---|
| | SA (*n*=18) | | NAC (*n*=22) | |
| Variables | *M* | *SD* | *M* | *SD* |
| Age (years) | 24.2 | 2.7 | 25.0 | 4.4 |
| Gender (% female) | 77.8 | | 68.8 | |
| LSAS** | 61.5 | 16.7 | 14.3 | 7.8 |
| STAI-Trait** | 46.1 | 7.7 | 31.4 | 6.7 |
| FDD** | 10.1 | 5.1 | 2.9 | 3.2 |

**$p < .001$, two-tailed.

day, they were allowed to continue the experiment. The remaining procedure was identical to the one described in Experiment 1B, except for the addition of the FDD (Kühner, 1997) to the set of questionnaires.

*Design and analyses.* Full combination of the within-subjects factors cue type (angry, neutral, smiling face) and cue validity (valid, invalid) with the between-subjects factor anxiety group (SFs, NACs) yielded a 3x2x2 factorial design. The participants' median RTs in each of the six experimental conditions were used as dependent variables. The following predictions were tested: First, there should be an overall IOR effect, such that responses to invalid trials should be faster than responses to valid trials. Second, the IOR effect after angry face cues should be significantly reduced in the highly socially anxious participants.

*Results and Discussion*

As in Experiment 1B, cue validity had a significant main effect on response latencies, $F(1,38) = 20.26$, MSE = 309.32, $p < .001$. Again, this was due to an IOR effect: Invalidly cued targets were detected more quickly than validly cued ones (342 vs. 352 ms, see Table 2.6b). And again, individual analyses of the IOR effects for the three different cue types revealed that it was significant for each cue, all $t(39) > 2.55$, $p < .02$). As before, neither did cue type yield a main effect, $F(2,76) = < 1$, MSE = 209.95, nor did it interact with cue validity, $F(2,76) < 1$, MSE = 268.50. The same was true for the factor anxiety group, which yielded neither a main effect on RTs nor any interaction (all $F < 1.2$, MSE < 210, $p > .05$). Most importantly, after angry facial cues, the IOR effect exhibited by SAs did not differ from the one shown by NACs, $F(1,38) < 1$.

To summarize, SAs and NACs did not react differently to the emotional face cues or the validity of the cues, and the IOR effect after angry face cues was not reduced in SAs. As in Experiment 1B, the manipulations resulted in a stable IOR effect, observable in both groups and after all cues.

## General Discussion

In three experiments, the effect of biologically relevant cues and threatening cues on inhibition of return was investigated. Pictures denoting objects of supposedly evolutionary relevance served as cues for a neutral target that had to be localized

after a delay of 550 ms from cue onset. In Experiments 1A and 2, the targets were cued validly and invalidly by drawings of spiders, butterflies, and crosses. An unselected sample of students (Part 1A of Experiment 1) as well as selected participants who were either highly spider fearful or not afraid of spiders (Experiment 2) participated in this visual cueing task. In Experiments 1 and 3, the cues were photographs of individuals looking angry, neutral, or smiling. These cues were presented to an unselected group of participants (Part 1B of Experiment 1), as well as to selected participants who were either highly socially anxious or non-anxious (Experiment 3). The experiments were designed to test the prediction that the IOR effect (faster responses to invalidly cued targets than to validly cued ones) would be reduced for anxiety evoking stimuli such as spiders and angry faces (Experiment 1). Furthermore, the reduction should be particularly large in fearful individuals for whom these stimuli are highly threatening, that is, spider fearful and socially anxious individuals, respectively (Experiments 2 and 3). The results of these three experiments were fairly clear-cut, and not in line with the predictions at all: In all experimental conditions of all experiments, invalid cueing facilitated responses compared to valid cueing, yielding reliable IOR effects. Neither type of cue nor fear level of the participants had any impact on the IOR effect whatsoever.

Previous studies of individual variables that may affect inhibition of return have shown that the effect may indeed be reduced by different kinds of psychopathology. For instance, Roelofs, et al. (2003) found that patients with conversion paresis showed a diminished inhibition of return, and Burdick (2003) reported that bipolar depression was related to decreases in inhibition of return. Nelson, Early, and Haller (1993) found reduced IOR in patients with obsessive-compulsive disorder, and speculated that these patients lack inhibitory attentional processes. However, Moritz and von Mühlenen (2005) could not confirm these findings of reduced IOR: Both patients and control participants consistently presented IOR effects, and the magnitude of the effect was not moderated by symptom severity, comorbid depression, nor medication use. In all of these studies, however, neutral cues and targets were used, in order to investigate the alteration of

IOR in general. Thus, the supposedly contradictory influence of threat detection on an automatic attentional process could not be assessed.

To the best of our knowledge, only four published studies addressed the question whether the general relevance of a cue or its individual threat value might influence the magnitude of IOR. While Fox et al., (2002) concluded from their study that angry faces serving as invalid cues do indeed eliminate the IOR effect in highly anxious participants, Taylor & Therrien (2005), found that the IOR effect was not influenced by neutral faces, neither when employed as cues nor as targets. Similarly, Stoyanova, Pratt, and Anderson (2007) found that neither fearful face cues, neutral face cues, nor luminance matched cues changed the magnitude of the observed IOR. In a slightly different version of the task, Theeuwes and van der Stigchel (2006) investigated the occurrence of IOR after simultaneous presentation of (neutral) face cues and household objects. The results revealed that only faces seemed to capture attention such that an IOR arose. Thus, the occurrence of the IOR effect instead of its reduction was taken as evidence for an attentional bias. Since no IOR occurred in response to household objects, it was impossible to tell whether the inhibition of return was reduced on the location of the formerly presented face. The different methodology of especially the latter study renders a comparison rather difficult.

Our results coincide well with those of Taylor and Therrien (2005) and Stoyanova and colleagues (2007) even though they did not employ threatening faces. As in their study, we found no influence of the type of facial expression on the IOR effect, neither in an unselected sample nor in socially anxious participants. In addition to the facial cues, we found that the IOR effect was also resistant against threat-related animal cues, namely spider pictures, both in an unselected sample and in highly spider fearfuls. Thus, in four tasks, IOR effects have proven to be resistant against effects of emotionally valenced, threatening cues. One might object, however, that despite the frequent replications, the statistical power of each individual experiment might have been insufficient. Therefore, we increased statistical power by combining the data of Experiment 1a and Experiment 2. With this sample of 100 participants, we again computed correlations of the SAS and FSQ scores with the IOR effect for spider cues. Please note that these correlations are

artificially inflated because Experiment 2 contained only extreme groups with regard to fear of spiders. Nevertheless, they remained low and insignificant (SAS: r = -.02, n.s.; FSQ: r = -.06, n.s.). The same result was observed when the data of Experiment 1b and Experiment 3 were combined. Even with this sample of 94 participants, the inflated correlation of the LSAS scores with the IOR effects for angry faces remained insignificant (r = -.08, n.s.). Therefore, we are quite confident that our findings cannot be explained by a lack of statistical power. Moreover, the fact that spiders as well as smiling and angry faces in our study, and fearful faces in the Stoyanova et al. study (2007) failed to affect the IOR, suggests that the IOR is resistant to a variety of emotional stimuli.

The finding that threatening stimuli had no effect on IOR stands in contrasts to the effects which have been observed many times with other experimental paradigms, including the dot probe task (e.g., Mogg et al., 2004), disengagement tasks (Fox et al., 2002), and free viewing tasks (e.g., Rinck & Becker, 2006). In these tasks, attentional biases of highly fearful individuals were observed, suggesting that threatening stimuli (e.g., spiders or angry faces) capture and hold attention, such that fearful individuals find it difficult to disengage their attention from these stimuli. Thus, the question arises why attentional biases have been observed for these tasks and processes, but not for tasks addressing IOR. One potential explanation might be that the stimulus materials used in the present experiments are not suitable for eliciting the expected effects because line drawings and black and white photographs might not be ecologically valid enough to represent the desired threat. This is rather unlikely, however, because many studies have employed comparable materials, and the very *same* materials have successfully evoked biases in other studies, for instance, automatic avoidance tendencies in social phobics (Heuer, Rinck, & Becker, 2007) or affective priming in spider fearfuls (Becker, Lange, Reinecke, & Rinck, 2006), respectively. Nevertheless, we are aware that a more direct, maybe even physiological validation of the threat potential of the stimuli would have been more elegant.

The lack of a theoretical framework in which a hypothetical interference of attentional bias and IOR can be placed, puts forward some theoretical and methodological questions. E.g., it could be argued that threat related stimuli could emphatically stress a location as already processed, rather than undermining the inhibition process. This would lead to a more exaggerated IOR. Evolutionarily, this makes no sense, though; since one would rather want to attend to immanent danger than avoid scanning its location again. Besides that, in highly anxious participants, attentional biases towards threat rather than away from it have been shown quite consistently.

Compared to other studies (e.g., Fox et al., 2002), one might believe that methodological deviations in our design could account for the lack of threat influences on IOR. First, we have used a target detection ("now") task rather than a target classification ("what") or target position ("where") task. It could be that increased cognitive load during a categorization decision makes vigilance processes more vulnerable to distraction/attraction by threat, compared to the simpler decision about a target's location, or the even simpler decision that *something* happened. In an extensive review, Schooten (2007; Chapter 1) listed an impressive amount of studies using diverging designs which nevertheless reported differential processing of threat cues/targets. Mogg and Bradley (1999) directly compared classification and position tasks and found that advantages for threat processing were equally strong in both designs. Additionally, Salemink, van den Hout, and Kindt (2007a) compared a categorization and a detection task and concluded that the latter might even be superior in detecting preferential processing of threat-related words (compare also: Wenzel & Holt, 1999). Therefore, we are confident that the probe detection procedure we employed is useful for detecting processes biases for threat-related stimuli, given there are any.

One might also object that our results are due to the fact that the presentation time of our cues (100 ms) was shorter than in many other studies. Bradley, Mogg, Falla, and Hamilton (1998) justly argue that presenting cues for 500 ms would facilitate comparability of findings from different studies. However, numerous studies have shown that presentation times of 200, 100 and even 17 ms are sufficient for

revealing differential threat processing in these paradigms (Cooper & Langton, 2006; Koster, Verschuere, Crombez, & Van Damme, 2005; Mogg & Bradley, 2002a, 2006).

Further, unlike Fox and colleagues (2002), and also Taylor and Therrien (2005), we did not use an intermediate cue to redirect attention from the cued location back to the fixation point and make a subsequent shifting to that locus a "real" return. If it were the case that, without such a procedure, attention had never moved from the (invalidly) cued location, IOR effects would never have occurred (compare: Lupianez et al., 2006). Thus, if the focus of attention would indeed remain on the location of the cue, valid trials would always be faster than invalid trials, independent of the length of the SOA. However, Stoyanova et al. (2007) have shown in two experiments that IOR was not influenced by fearful faces, neither with nor without an intermediate redirection of attention (see also Footnote). Additionally, one could argue that non-anxious controls have a tendency to avoid attention to threatening stimuli (e.g., Mansell, Clark, Ehlers, & Chen, 1999) and that consequently, IOR should be inflated. But if that were the case, correlations between degree of anxiety, or group differences would have been observed.

A major concern is though, that the observed IOR could also be easily attributed to forward masking. Since (visual) attention to a target often seems to be corrupted when preceded by another stimulus in the same location, it is possible that valid trials are generally disadvantaged over invalid trials. If that was a stable effect, consequences of threat stimuli might be overwritten by the effect of forward masking. To exclude such an explanation, it would have been necessary to present the target on valid trials close to, but not *on* the location of the cue. Nevertheless, the large IOR literature suggests that both procedures lead to effects attributable to IOR (compare Footnote). Berlucchi (2006) suggests that both single and bilateral cuing bring forth inhibition, with the latter not being explicable by forward masking. More importantly, he refers to studies by Possamai (1986), and Tassinari, Biscaldi, Marzi, and Berlucchi (1989), who also explored RTs to *centrally* presented cues and targets. They all assumed that the observed inhibition is merely due to sensory "bottom-up" influence, meaning that some low level cue property initiates (local) inhibition, not forward masking as consequence of stimulus sequence (compare: Berlucchi, 2006).

Consequently, this could also explain why the presentation of threatening cues in our experiments did not interfere with such an inhibitory process: Stimulus recognition or stimulus valance are determined “top-down”, that is, based on individual experiences. If energy changes in the visuospatial field are detected and lead to subsequent inhibition of a locus, the valence of a cue might not “get the chance to make a difference”.

A last potential explanation might be that compared to other experimental paradigms, IOR tasks have rarely been used. Thus, the boundary conditions for affective modulations of the IOR effect have not been identified yet, even though they might exist (but see Footnote). Until these are identified, however, we have to conclude that inhibition of return is a surprisingly stable phenomenon, unimpressed by affective valence of the cues. IOR might indeed be an evolved mechanism that promotes novelty in one’s visual field (Klein & MacInnes, 1999). This mechanism may be so strong that is not easily overruled by other evolutionary relevant functions, such as the detection of potentially harmful stimuli in the environment. Future research will have to show whether this is indeed the case with different stimuli and different individuals.

## Footnotes

[1]Although not of theoretical interest, the SOAs of 150 and 250 ms were also analyzed. Unlike some other studies (e.g., Koster, Crombez, Verschuere, Damme, & Wiersema, 2006), we did not find any attentional cueing at these SOAs. Instead, we found stable IOR effects that were unchallenged by cue valence. A thorough analysis of related research reveals that this finding is not as surprising as it might seem at first glance. In fact, the occurrence of IOR instead of facilitative cueing is highly likely, even at short SOAs, under the circumstances employed in our experiments: (a) There is no intermediate cue that would redirect attention to the fixation point (unlike e.g., E. Fox et al., 2002). This has been shown to lead to IOR effects at SOAs between 200 and 800 ms (Pratt & Fischer, 2002). (b) Cues and targets were physically different, but appeared in the same spatial location. This has previously produced IOR-like response patterns even for SOAs of 100 and 200 ms, while facilitative cueing occurred when cue and target did not overlap spatially (McAuliffe & Pratt, (2005). McAuliffe and Pratt (2005) systematically investigated the role of target-cue overlap in time and space, and found that spatially overlapping cues did not produce any cueing, regardless of the interstimulus interval (ISI). Instead, they observed IOR at SOAs of 400 and 800 ms across all ISIs. In summary, we have good reason to believe that IOR is a stable process unchallenged by cue valence. Since our results observed at SOAs of 150 ms and 250 ms resemble those found at 550 ms, they are not reported here, in order to save space.

Chapter 3

# Disturbing Emotions: Do Angry Women or Angry Men Disturb Target Categorization ?

This chapter is submitted as: Lange, W.-G., Keijsers, G.P.J., Rinck, M., & Becker, E.S. (2008). Disturbing emotions: Do angry women or angry men disturb target categorization ?

## Abstract

Cognitive models of anxiety disorders hypothesize that automatic processing of emotional faces serves an evolutionarily advantage by preparing prompt reactions in critical social situations. Experimental findings with face stimuli are ambivalent, however. In the present study, face categorization was assessed by an adapted version of Erikson's classical flanker paradigm. Socially anxious participants had to categorize the target face's emotion (angry, neutral, smiling) while ignoring flanking emotional faces. The categorization of angry female and smiling male targets took participants longer than that of angry males or smiling females. Flanker emotion by itself or degree of social anxiety did not make any difference.

## Introduction

In recent years, it has repeatedly been suggested that biases in the information processing of patients diagnosed with an anxiety disorder may contribute to the initiation or maintenance of their disorder (e.g., Beck & Clark, 1997; Clark & Wells, 1995; Rapee & Heimberg, 1997). One mechanism which biases anxiety patients' automatic attention towards threat cues is called selective attention (Mathews & Mackintosh, 1998). Normally, its purpose is to focus on relevant input while irrelevant, distracting information in the vicinity is being filtered out or ignored (Gazzaniga, Nangun, & Ivry, 2002; Kandel, Schwartz, & Jessell, 2000). In anxiety prone patients, though, it seems that the "relevance evaluation" is out of balance and the threat evaluation exaggerated. It has, for example, been found that spider fearfuls are hypervigilant to spiders in their environment (Becker & Rinck, 2004; Rinck, Reinecke, Ellwart, Heuer, & Becker, 2005), that physiology/panic related words distract attention of patients with a panic disorder (e.g., Asmundson, Sandler, Wilson, & Walker, 1992; Kampman, Keijsers, Verbraak, Näring, & Hoogduin, 2002), and that socially threatening words distract socially anxious participants in an emotional Stroop task (Andersson, Westoo, Johansson, & Carlbring, 2006; Lundh & Öst, 2001). It has also been suggested that angry facial expressions have evolutionary relevance (Haxby et al., 2000; Öhman, 2002; Öhman, Flykt et al., 2001; Öhman & Mineka, 2001) and may evoke social threat to such an extent that they also cause attentional disruption. Facial expressions of negative emotions are thought to be particularly relevant to socially anxious people due to their heightened sensitivity to social interaction and the fear of being rejected, ridiculed, or scrutinized

(APA, 2000). Indeed, it has been shown that in visual search tasks, socially anxious and, to a lesser degree, also non-anxious individuals detected angry faces in a crowd more quickly than other emotional faces and were more distracted when looking for other emotions in an angry crowd (compare: Gilboa-Schechtman, Foa, & Amir, 1999; Hansen & Hansen, 1988; Öhman, Lundqvist, & Esteves, 2001). Juth et al. (2005), on the other hand, found a detection advantage for happy faces. This advantage was not mediated by (social) anxiety. Other attention tasks using single (threatening) targets revealed conflicting results for angry faces as well. In a recent neuroimaging study by Monk, Nelson, McClure, et al. (2006), adolescent participants diagnosed with general anxiety disorder showed a higher right ventrolateral prefrontal cortex activation for angry faces. Reaction time data, however, revealed an attentional bias away from those faces and towards neutral faces. In other studies, Mogg, Philippot, and Bradley (2004), reported a quick initial orientation towards threatening schematic faces in social phobic participants, while Georgiou, Bleakley, Hayward et al. (2005) found that anxious participants took longer to move their attention away from fearful as opposed to neutral, sad, or happy faces (compare: Fox et al., 2001, Exp. 5; Pourtois, Schwartz, Seghier, Lazeyras, & Vuilleumier, 2006). In this paradigm, participants had to categorize target letters that were presented in the periphery of a centrally presented (emotional) face (Georgiou et al., 2005). Georgiou and colleagues concluded that attention was not so much reflexively captured by threatening faces but that disengagement from these faces was disrupted. Christianson (1992) offered another explanation for disruptions in the processing of peripheral cues when a centrally presented stimulus is threatening. He supposed that threat might evoke physiological arousal, which consequently steers

attention to central aspects of a situation ignoring the surroundings (attentional narrowing hypotheses; Easterbrook, 1959; Wessel, van der Kooy, & Merckelbach, 2000). Research on eye-witness reports of crime scenes reports a similar phenomenon, here called “weapon focus” (Loftus, Loftus, & Messo, 1987; Fenske & Eastwood, 2003): When confronted with threatening situations (e.g., a robbery) victims seem to automatically focus on the direct source of threat, for example the gun. By doing so, they tend to blind out everything else in the scene, leading to a restricted memory of the incident afterwards.

The aforementioned paradigms share one common feature: Two or more stimuli compete for attention ("stimulus competition"; compare: Yiend & Mathews, 2005) and task completion asks for attentional shifting. In order to investigate the role of stimulus competition, while task completion does not require attentional shifting, Fenske and Eastwood (2003) employed Eriksen and Eriksen’s flanker paradigm, introduced in 1974. In Fenske and Eastwood's study, participants had to categorize centrally presented stimuli (e.g., emotional faces), while ignoring flanking stimuli (flankers) to the left and/or right of the target. Thus, the flanking distracters are not necessary/relevant for task completion, which is identification and categorization of the target. Yet, flankers do influence performance on the task under certain circumstances. Eriksen and Eriksen (1974) found that targets can be categorized quicker if target and flankers are similar (flanker-compatibility effect) and when flankers are further away. Fenske and Eastwood (2003) hypothesized that attentional narrowing following threatening schematic faces would undermine the compatibility effect. They expected that a more restricted diameter of attention would facilitate target categorization because facilitating similar flankers and distracting

dissimilar flankers lie beyond the diameter. In a series of experiments with unselected samples, Fenske and Eastwood (2003) indeed found that the flanker-compatibility effect was reduced when angry target faces had to be categorized. Flankers differing from angry target faces caused less interference than flankers differing from neutral or smiling target faces (for alternative interpretation of results see: Horstmann, Borgstedt, & Heumann, 2006).

Surprisingly, almost all the studies reported above have one shortcoming in common: stimulus-gender has seldom been taken into account in studies that make use of real face stimuli. In evolutionary terms, survival means reproduction, and finding a mate among the opposite sex forms the basis for that (Darwin, 1859). Insufficient recognition of either invitation for alliances/mating or signals of threat might lead to exclusion from a group, which might have been fatal, too (Gilbert, 2001; Sapolsky, 2004). A frown of a same-sex group member, for example, might jeopardize alliances and sympathy in a group, while a smile of an opposite-sex group member might reflect interest and willingness to mate. The implication is that an angry face might be more pressing if displayed by a same-sex member, while a smile might be more important when shown by an opposite-sex member. On the other hand, it is thinkable that a more general mechanism facilitates processing of angry males, since they are generally more threatening. Following this argument, immediate attentional shift towards and speeded processing of angry faces should be more pronounced when displayed by men than when displayed by women (compare: Becker et al., 2007).

In sum, research results with emotional facial expressions have not been particularly consistent with regard to attentional biases in social anxiety. The use of

different paradigms testing different aspects of attentional processes, and the ignorance of stimulus- and participant gender makes matters even more complicated.

In the present study, we therefore explored how target and distracter emotion affect emotion categorization by using an adapted version of Eriksen's classical flanker paradigm (Eriksen & Eriksen, 1974) as applied by Fenske and Eastwood (2003). Distraction by task-irrelevant flankers is reflected in increased response latencies when categorizing a centrally presented target (Ro, Machado, Kanwisher, & Rafal, 2002; Sanders & Lamers, 2002). Instead of letters or schematic faces, we used photos of emotional faces of males and females as targets and flankers. Here, the emotion of the presented target had to be categorized. Target and flanker showed the same male or female individual while the emotional expressions differed in 66% of the trials. Additionally, we varied the distance between target and flankers. Two groups of participants were tested: a group of highly socially anxious individuals (SAs) and a group of non-anxious individuals (NACs). To simplify matters, all participants were female.

Following Eriksen and Eriksen's (1974) findings, it was hypothesized that close flankers would distract participants more than far flankers. Further, it was predicted that flankers showing the same emotion as the target cause less interference than flankers differing from the target emotion (flanker-congruency effect; Eriksen & Eriksen, 1974). These are the classical flanker effects. In line with prior findings and central to the present study, we hypothesized that categorization of angry face targets would, due to attentional narrowing, be less affected by flanker dissimilarity or close flanker distance. Based on the assumption that facial

expressions have an important communicative value in social interaction, detecting rejection, contempt, disapproval, sympathy, or anger in a facial expression might be particularly threatening for people suffering from social anxiety (compare: American Psychiatric Association, 2000 [APA]; Mathews & MacLeod, 2005). Even though Fenske and Eastwood did not test a specific hypothesis concerning flanker emotion, it seems plausible that angry flankers would distract target categorization. Consequently, as a subordinate hypothesis, we assumed that the distraction by flanking angry faces, while categorizing a target with a different expression, might be more pronounced in SAs. More importantly, though, when presented with an angry target, the flankers' distracting potential should be significantly reduced in SAs, and the flanker-compatibility effect should be smaller than in NACs. Finally, if general evolution-based mechanisms are indeed intertwined with gender-specific processes, the facilitation of target categorization should be even stronger with male angry targets than with angry female targets. Likewise, the classical flanker effects should be more reduced. Again, both processes should be mediated by social anxiety.

## Methods

*Prescreening & participants*

For prescreening purposes, psychology students of Radboud University Nijmegen were asked to complete the Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987; Mennin et al., 2002) during second-year lectures. Those willing to participate were selected according to their LSAS scores (≤ 13 or ≥ 27 on the LSAS anxiety-subscale) and invited for an experimental session. This procedure resulted in a selected sample of 27 socially anxious females (SAs) and 34 non-anxious control

females (NACs). An experimental session lasted for 25 minutes, for which participants received a payment of €3 or course credit.

*Measures*

Before the computer task, participants again completed the LSAS. Further, they filled in the Fear of Negative Evaluation Scale (FNE; Duke, Krishnan, Faith, & Storch, 2006; Leary, 1983), the state-version of the State/Trait Anxiety Inventory (here: STAI-State1; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983; Spielberger, Gorsuch, & Lushene, 1970), and a general screening instrument for eyesight, handedness, education, and use of medication. After the computer tasks, participants filled in the STAI for the second time (here: STAI-State2), the Symptom Check List-90 (SCL-90; Derogatis, 1994), a self-report instrument for psychopathological symptoms, the Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961), and the trait-version of the STAI (STAI-Trait).

*Apparatus & stimuli*

The experiment was conducted on an Apple eMac with integrated 17” monitor, operating at 700 MHz on Mac OS X 10.2.8. Stimulus presentation, reaction time and error recording was controlled by the software RSVP 4.0.5 for Macintosh (Williams & Tarr, 1998).

A selection of color photos of 4 individuals (2 males and 2 females), each presenting three different expressions: angry, neutral, and smiling, was taken from the Karolinska Directed Emotional Faces database (KDEF; Lundqvist, Flykt, & Öhman, 1998). The pictures were resized to 56,0 mm X 78,0 mm, 32-bit color.

*Procedure*

As stated above, students were pre-selected according to their LSAS scores (≤13 and ≥27 on the anxiety-subscale). On arrival, they filled in the LSAS for a second time. Participants scoring above 13 or below 27 were excluded, thanked for their effort, and given a lollipop for their efforts.

The remaining participants completed the first set of the questionnaires. Then the computer program was started. Participants were seated about 50 cm from the computer monitor and told that all instructions were shown on the screen and that there would be plenty of time to practice. If they had questions, participants were asked to pose them before or after the practice-trials. The participants' task was to identify the expression of the target individual shown in the middle of a row of three photos. They responded by pressing one of the keys marked with "☺"- (smile), "😐"- (neutral) and "☹"- (angry) on the otherwise covered standard computer keyboard. The presented pictures within a trial always showed the same person, and the emotional expressions of the two flanking pictures ("flankers") were always identical. They could differ from the facial expression of the center picture ("target") however. Participants were told to ignore the flankers and focus on the central picture in order to give an accurate judgment. The row was presented for 500 ms, and the trial lasted until participants reacted. There were three different locations possible for the flankers to appear: 5.75 cm (close), 9.5 cm (intermediate), or 13.0 cm (far) to the left and right of the screen center.

The sequence of a trial was as follows: a yellow fixation cross was displayed in the center of a blue screen for 1000 ms. The three photos were then presented for 500 ms, with the two flanking photos appearing both close, intermediate or far from

the centered target picture. After 1500 ms, a buzzer alerted the participants if they had not reacted yet.

Participants were given 54 practice trials to get used to the experimental setup and five sets of 108 trials each in the main experiment. The total of 540 trials was divided equally into 180 trials per flanker distance (short, intermediate, far). Each position was combined with each type of facial expression (angry, neutral, smiling) on 60 trials, equally randomized over individual and photo gender (2 females, 2 males). After finishing the computer tasks, participants were asked to fill in the remainder of the questionnaires, were debriefed, paid, and thanked for their effort.

*Design*

Neutral facial expressions and intermediate flanker positions were presented for the variability of the task, but were not considered in the analyses. Consequently, a 2 (target gender: female, male) × 2 (target emotion: angry, smiling) × 2 (flanker emotion: angry, smiling) × 2 (flanker distance: short, far) × 2 (social anxiety: low, high) factorial design resulted for the RT analyses. While target and flanker emotion, target gender and flanker distance were within-subjects factors, anxiety was a between-subjects factor. Whenever the basic assumption of univariate testing (sphericity) was violated in any of the analyses, more conservative tests with corrections of degrees of freedom were used (here: Huynh-Feldt).

## Emotion Categorization Task: Results

*Population characteristics*. The NACs (*M* = 19.41 years; *SD* = 1.42) and the SAs (*M* = 19.44 years; *SD* = 1.50) did not significantly differ in age, $t(59) = -0.09$; $p = .93$, or education, $\chi^2(2, N = 61) = 0.6$, $p = .97$. On questionnaires, both groups differed significantly on items assessing anxiety-related concepts and comorbidity (for details see: Table 3.1). Only state anxiety in NACs had increased somewhat after the computer task, such that the difference was marginally significant. The interaction of time of measurement and state anxiety was not significant, $F(1, 59) = 1.9$; MSE = 26.10; $p = .18$, though.

**Table 3.1** *Means (M) and standard deviations (SD) of questionnaire scores for socially anxious (SAs) and non-anxious control (NACs) participants: Liebowitz Social Anxiety Scale (LSAS), Fear of Negative Evaluation (FNE), the trait and state versions of the Spielberger State/Trait Anxiety Inventory (STAI-Trait, STAI-State1, STAI-State2), Beck's Depression Inventory (BDI), and the Symptom Check List-90 (SCL-90)*

| Questionnaire | SA (*n* = 27) | | NAC (*n* = 34) | |
|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* |
| LSAS** | 37.0 | 7.4 | 8.3 | 2.6 |
| FNE** | 34.8 | 7.2 | 13.9 | 6.6 |
| STAI-Trait** | 41.9 | 9.7 | 31.9 | 6.7 |
| STAI-State1** | 39.5 | 8.1 | 32.4 | 8.2 |
| STAI-State2 | 39.1 | 10.1 | 34.6 | 9.2 |
| BDI* | 9.4 | 5.3 | 5.0 | 4.1 |
| SCL90** | 150.0 | 30.6 | 117.8 | 24.2 |

*$p < .01$, two-tailed. **$p < .001$, two-tailed.

*RTs for categorization in general.* As would be expected from the flanker literature, there was a significant main effect for flanker distance, $F(1, 59) = 7.87$; MSE = 3720.36; $p < .01$. Emotion categorization was quicker when the flanker was “far” than when it was “close” to the target. The influence of (dis-)similarity of target and flanker was reflected in a significant interaction of target emotion and flanker emotion, $F(1, 59) = 5.37$; MSE = 2892.13; $p < .05$. Identical emotions in target and flankers led to a quicker identification than incongruent emotions. Thus, we found the classical flanker effects (distance and flanker congruency effect) as observed by Eriksen and Eriksen (1974).

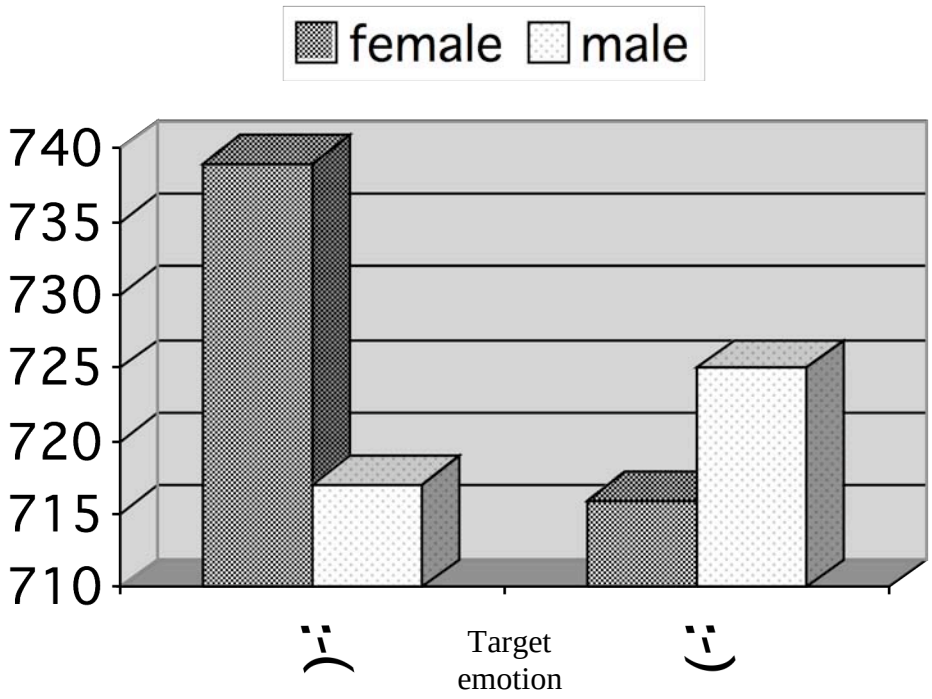


**Figure 3.1** *Mean reaction times (RT) in milliseconds (ms) per target emotion and target gender.*

Target gender interacted with target emotion in a way that categorization was facilitated by smiling female and angry male targets, $F(1, 59) = 12.34$; MSE = 4472.19; $p < .01$ (Table 3.2, Figure 3.1). When analyzed in more detail, it appeared that RTs to male angry targets were significantly faster than to female angry targets, $t(60) = 3.57$; $p < .01$, while responses to male smiling and female smiling faces were

**Table 3.2** *Mean reaction times (in milliseconds) of correct trials, for the two types of target/flanker expressions, sorted by group, target gender and target distance (SD in parenthesis)*

| | | SA ($n$ = 27) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Target Gender | | | | | | | |
| | | Female | | | | Male | | | |
| | | Flanker distance | | | | Flanker distance | | | |
| | | Far | | Close | | Far | | Close | |
| | | ☹ | ☺ | ☹ | ☺ | ☹ | ☺ | ☹ | ☺ |
| Target | ☹ | 729 (87) | 738 (104) | 723 (85) | 740 (102) | 703 (80) | 718 (104) | 731 (112) | 733 (102) |
| | ☺ | 714 (104) | 715 (108) | 714 (89) | 720 (103) | 709 (86) | 709 (97) | 731 (79) | 723 (98) |
| | | NAC ($n$ = 34) | | | | | | | |
| | | Target Gender | | | | | | | |
| | | Female | | | | Male | | | |
| | | Flanker distance | | | | Flanker distance | | | |
| | | Far | | Close | | Far | | Close | |
| | | ☹ | ☺ | ☹ | ☺ | ☹ | ☺ | ☹ | ☺ |
| Target | ☹ | 728 (93) | 734 (88) | 752 (97) | 764 (89) | 717 (80) | 706 (81) | 704 (91) | 722 (87) |
| | ☺ | 719 (106) | 708 (101) | 730 (104) | 704 (85) | 723 (87) | 721 (105) | 747 (84) | 729 (94) |

not different, $t(60) = 1.55$; $p = .13$. When the response latencies were compared within target gender, it became obvious that female angry targets elicited significantly longer RTs than happy females, $t(60) = 3.38$; $p < .01$, while reactions to the two male emotions did not differ, $t(60) = 1.34$, $p = .18$. This means that the observed interaction between gender and emotion was mainly determined by the slowed categorization of angry female targets. Further, no main effect was observed for target emotion or flanker emotion, $F(1, 59) = 2.3$; MSE = 6269.60; p = .13, and $F(1, 59) < 1$, respectively. Neither the main effect of group, $F(1, 59) = < 1$, MSE = 88000.04; $p = .84$, nor any of its relevant interactions reached statistical significance. Thus, neither flanker emotion, target emotion, nor the flanker compatibility effect was altered by the degree of social anxiety.

## Discussion

In the present study, we investigated attention disruption by threatening, task-irrelevant flanking/distracting faces on the categorization of emotional target faces. Second, we examined the change of focus diameter when threatening targets had to be categorized, and how that influences the disrupting properties of flanking stimuli. Third, it was examined whether those effects were mediated by degree of social anxiety. We also assumed that anger depicted by a angry male might be more influential than anger displayed by a female, an effect that should be more pronounced within the socially anxious females tested here. Generally, as would be expected from theory, close flankers slowed latencies down significantly more than far flankers.

Also, the flanker compatibility effect reached statistical significance: Identity of flanker emotion and target emotion facilitated emotion categorization. The claim that a particular target *or* flanker emotion plays a relevant role in facilitating or impeding task performance could not be substantiated, however, because none of the related main effects nor interactions were significant. Social anxiety did not affect any of the classical flanker task effects, either. Instead, categorization of emotional expressions in SAs as well as in NACs was significantly faster when either happy female targets or angry male targets were presented.

Despite the fact that the manipulation itself seemed to have worked, none of our hypotheses concerning social anxiety or angry faces in general could be substantiated. In contrast to Fenske and Eastwood (2003) who had found that the classical flanker compatibility effect disappeared when angry target faces were used, we employed pictures of real faces and not schematic ones. It has been suggested by Öhman, Lundqvist, and Esteves (2001) that choosing ecologically valid stimuli, such as real faces instead of schematic ones, might add considerable variance to the obtained data and therefore dilute the strength of effects. If that was the case here, then a larger sample might have been needed. Considering the equivocal findings for facial threat in social anxiety, it is also possible, however, that the flanker paradigm grasps aspects of attention which are only mildly disrupted by the processing of emotional information. Horstmann et al. (2006) have already argued that Fenske and Eastwood's findings might be attributable to perceptual differences in the (emotional) stimuli rather than to the processing of depicted emotions. Additionally, it is possible that the facilitation of particular gender-emotion

combinations overrides influences of a second order such as, for example, degree of social anxiety.

To understand the strong impact gender has on emotion categorization, it could be argued that gender recognition, compared to emotion processing, is of similar importance or at least similarly automated. Indeed, there are different neurological structures that facilitate gender recognition (read: recognition of unchangeable features; Haxby et al., 2000). In evolutionary terms, facial expressions of *angry males* and *smiling females* should be preferentially processed by females because the former signals threat by a stronger and more aggressive male group member, while the latter indicates potential alliance not linked to mating. Accordingly, Becker et al. (2007) provided evidence that socialization or role stereotypes (e.g., smiling females and angry males are more common, or role-compliant; LaFrance, Hecht, & Paluck, 2003) provide no sufficient explanation for the detected gender-emotion interaction. Becker et al. argued that core visual/morphological features of male and female faces are associated with anger and happiness, respectively. In Experiment 7 of their study, they manipulated computer generated androgynous neutral faces by changing prominent gender cues: Bony structure of the brow ridge (lowered vs. raised), jaw (square vs. round/narrow) and clothing (male vs. female). Participants had to rate the faces in terms of masculinity, femininity, anger, and happiness. The results indicated that lowering of the brow ridge did indeed lead to increased ratings of masculinity and anger (Becker et al., 2007). Interestingly, the clothing manipulation initiated judgments incompatible to those suggested by gender stereotypes or gender roles (see: Plant, Hyde, Keltner, & Devine, 2000). Moreover, they discovered the aforementioned gender-emotion interaction in male as well as

female participants, which opts for more general nature of the mechanism. Females are seemingly apt to be more befriending (e.g., Taylor et al., 2000), and facing aggression is more dangerous with bigger opponents which are most likely male (Daly & Wilson, 1994). Taken together, the presented results imply an evolutionarily/morphologically based processing facilitation when (female) participants categorize angry male and smiling female faces.

The presented results raise the question why target (or distracter) gender has seldom been taken into account as a potentially relevant factor in facial threat research. In fact, many experiments intermix female and male stimulus materials without controlling for stimulus gender (e.g., Fox, Russo, & Georgiou, 2005; Gilboa-Schechtman, Presburger, Marom, & Hermesh, 2005). This should, in the light of the results presented above, be reconsidered. If, for instance, in the present study, means per condition and emotion had been calculated disregarding stimulus gender, the relative slowing of angry female faces would have leveled out the speeding in angry male faces. Consequently, no difference for angry faces would have been detected with regard to the other emotions.

Methodologically, this causes a problem, too, since several studies used gender categorization as implicit means of measuring responses to varied emotional valence (e.g., Arcuri, Castelli, Boca, Lorenzi Cioldi, & Dafflon, 2001; Rotteveel & Phaf, 2004). Assuming that neurological hardwiring facilitates emotion *and* gender categorization in general, but also specifically angry males and happy females, it is likely that both factors add considerable variance to response latencies, thereby making interpretations of the results more difficult. Additionally, females appear to be better/quicker at emotion processing than males are (Hall, 1978; Hampson, van

Anders, & Mullin, 2006). This indicates that controlling for participant gender might explain *additional* variance. In the study presented here, this problem was avoided by testing only females. In future studies, though, both genders should be tested.

Taking these arguments into account, it is obvious that controlling for stimulus gender as well as participant gender should be standard procedure when emotional face materials are used. By doing so, the understanding of emotion processing, the evaluation of observed effects, and the statistical power of studies could be improved in future research.

Chapter 4

# Morphed Emotions:

# Emotion Detection and Misinterpretation in Social Anxiety

A slightly adapted version of this chapter is to be submitted as: Lange, W.-G., Heuer, K., Keijsers, G.P.J, Rinck, M., & Becker, E.S. (2007). Morphed emotions: Emotion detection and misinterpretation in social anxiety.

## Abstract

The present study was designed to examine processing biases for emotional facial expressions in 27 High Socially Anxious individuals and 30 Non Anxious Controls. Participants were presented with morphed movies showing a neutral face gradually changing into an emotional facial expression (anger, disgust, happiness). Decoding accuracy, and response time to recognize the developing emotion was assessed under two conditions: A restricted viewing task with time limitation and a free viewing task (FVT) with no time constrains and possibilities to re-view the film. Both groups did not differ in the accuracy or speed of recognizing expressions, but in the kind of errors they made: results of the RVT indicate a tendency of high socially anxious participants to interpret first signs of disgust as contempt. No processing biases were evident for angry faces. The FVT did not reveal any group differences at all.

## Introduction

Social Phobia (Social Anxiety Disorder, SAD) is a common and debilitating disorder, characterized by marked and persistent fear of one or more social and performance situations in which the person is exposed to unfamiliar people or to possible scrutiny by others (American Psychiatric Association, 2000), and which may eventually lead to rejection and social isolation. Cognitive models of social phobia ascribe a significant role in the etiology and maintenance of the disorder to distorted cognitive processes (e.g., Beck, Emery, & Greenberg, 1985; Clark & Wells, 1995; Rapee & Heimberg, 1997). These models however, focus on different facets of biased processing resulting in different predictions: for example, Beck et al. (1985) suggested that social cues can trigger "social threat schemata" in socially anxious individuals. These schemata are supposed to attract attention of threat-confirming information and neglect disconfirming evidence in one's environment. According to Beck's content-specificity hypothesis (Beck, 1976), these biases should then only refer to disorder specific themes and cues: e.g., social threat for social anxiety disorder. Additionally, the individual does not only focus on seemingly threatening cues but is also inclined to disregard or even reinterpret positive or ambiguous signals. Clark and Wells (1995) elaborated further on that idea. When confronted with conjectural social threat, they believe that socially anxious individuals turn their focus on themselves, monitoring themselves as social beings and their (observable) symptoms of anxiety. It is supposed that self-focused attention increases anxiety, keeps the anxious individual from observing relevant (maybe threat disconfirming) social cues, and makes them, under more, behave socially inappropriate. Rapee and

Heimberg (1997) clearly advocate an attentional bias towards and disrupted disengagement from threat cues once such a threat evaluation is made. Taken together, these models lead to contradictory suggestions: On the one hand, socially anxious individuals are thought to have a tendency to quickly detect or recognize cues of social threat or of cues that are readily interpreted as such. Later on, the anxious individual is believed to have difficulty disengaging his or her attention from that cue. On the other hand, social anxiety is supposed to be associated with an inward focus of attention in a social situation and thereby missing socially relevant and maybe even disconfirming social cues. Facial expressions are thought to be powerful and among the most relevant social cues in (human) interaction (e.g., Bradley et al., 1997; Ekman & Friesen, 1971; Öhman, 2002). The fact that distinct neurological hardwiring facilitates face processing (Haxby et al., 2000; Herrmann et al., 2005; Vuilleumier, 2002, 2005) accentuates the evolutionary relevance of facial expressions and their decoding (Haxby et al., 2000; Juth et al., 2005; Öhman, 2002; Öhman, Flykt et al., 2001; Öhman & Mineka, 2001) for communication and interaction. The capability to recognize the meaning of facial expressions helps human beings to obviate conflicts, identify intentions and attitudes of others, and readjust one's own behavior accordingly (Hess, Kappas, & Scherer, 1988; Salovey & Mayer, 1990). Similar to verbal communication, facial expression in an interaction can readily express sympathy and interest but also e.g., rejection or contempt, the foremost fear in socially anxious individuals. Additionally, facial expressions can be quite ambiguous, and leave much room for (mis-)interpretation (compare: Clark, 2001). Consequently, the skill to distinguish facial expressions of others correctly is crucial for smooth social interaction and healthy personal relationships whereas

disturbances herein can have far-reaching consequences which may eventually lead to rejection and isolation (Carton, Kessler, & Pape, 1999). Facial expressions have therefore gained a considerable amount of attention in the research especially of social phobia (Douilliez & Philippot, 2003; Merckelbach, Van Hout, Van den Hout, & Mersch, 1989; Philippot & Douilliez, 2005).

Arguing along the lines of the cognitive models outlined above, there should be considerable evidence that facial expressions relevant to social threat are processed *differently* by socially anxious individuals than other emotional expressions. “Differently”, however, indicates that the range of possibilities is manifold. And indeed, quite a lot of experimental investigations using visual search or probe tasks report for example speeded processing of or attentional *vigilance* towards angry faces (e.g., Bradley, Mogg, & Millar, 2000; Gilboa-Schechtman, Foa, & Amir, 1999; Maieritsch & Walter, 2003; Mogg & Bradley, 2002a, 2002b; Mogg et al., 2004; Pishyar et al., 2004) as would be predicted by the model of Rapee & Heimberg (1997). Others, however, report attentional *avoidance* patterns for social threat cues instead (e.g., Mansell et al., 1999; Stirling, Eley, & Clark, 2006), or even both: first vigilance, then avoidance (for critical reviews see: Hermans & van Honk, 2006; Ledley & Heimberg, 2006). Along this line it could be hypothesized that speeded processing of threatening facial expressions would lead to fast recognition of these (threatening) faces, while attentional avoidance as well as self-focus in a social situation (compare: Clark & Wells, 1995) leads to slowed or erroneous recognition. Thus, an investigation of recognition speed and accuracy of (particular) facial expressions in a socially anxious population would allow inferences about the direction of underlying attentional and interpretational processes.

Following this train of thought, researchers have explored the accuracy and speed of emotion recognition in socially anxious individuals and non-anxious controls. In a prototypical experiment, participants would be asked to identify/label or sort (different intensities) of depicted emotional expressions as quickly as possible. Mohlman, Carmin and Price (2007) implemented a speeded emotional card-sorting task to investigate sorting accuracy and interpretation biases in individuals with social anxiety disorder. Participants with a diagnosis of general social phobia were more accurate in sorting angry face cards, but had also the tendency to interpret neutral cards as angry. Schofield, Coles, and Gibb (2007) did not find any sensitivity differences between high and low socially anxious participants when asked to detect the degree of negative evaluation in different intensities of happy, disgust and neutral expressions. However, socially high anxious individuals estimated the social cost of interacting with someone displaying a disgust expression to be significantly higher. Philippot and Douilliez (2005) confronted socially phobic individuals, anxious controls and non-anxious controls with different intensities (0%, 30%, 70%, 100%) of happy, angry, sad, disgusted, and fearful faces. Participants were asked to decide to what degree the portrayed emotion would resemble shame, surprise, anger disgust, sadness, fear or happiness. Philippot and Douilliez (2005) reported that the tested groups showed neither a superiority nor deficit in decoding any of the emotions. Accordingly, Winton, Clark, and Edelmann (1995) found that social anxiety was not related to an enhanced ability to discriminate between different facial expressions. Instead, social anxiety was associated with interpreting others' facial expressions as more negative (see also: Douilliez & Philippot, 2003; Gilboa-Schechtman et al., 2005). Mullins and Duke (2004), who investigated the decoding of emotional facial

expressions (happy, sad, angry, fearful) in social anxiety failed to find accuracy superiority/deficits, but interestingly could show that social anxiety scores were correlated with longer response latencies to identify emotions. The same was reported by Melfsen and Florin (2002), who investigated deficits in classifying facial expressions by socially anxious children. Abrams (1999), however, found limited support for a deficit of socially anxious participants when decoding low-intensity facial cues of emotion. Unequivocal support for a decoding deficit was only reported by one study: Simonian, Beidel, Turner, Berkes, and Long (2001) found a strong deficit in socially phobic children and adolescents to decode especially expressions of happiness, sadness and disgust (see also: McClure & Nowicki, 2001). Taken together, there is only equivocal evidence that individuals with high degrees of social anxiety have a predominant attentional bias towards e.g., angry faces, nor is there any convincing proof of speeded recognition or higher recognition accuracy of threatening faces measured with the employed paradigms and stimuli.

One reason for these inconsistent results, may lay in the selection of stimuli. Beck's content-specificity hypothesis implies that for social anxiety social threat stimuli should readily evoke a cognitive bias. In the reviewed studies however, there is no mutual agreement about which facial expressions fulfill these conditions. Anger is frequently seen as most distinct signal of disagreement or rejection and commonly utilized in experimental paradigms. Fear might as well fit the cognitive schema as it mirrors the socially anxious individual's own emotional state. Contempt would probably be the most logical choice as it reflects rejection right away. However, the facial expression of contempt is not as well-defined as would be desirable for research as contempt can readily be seen as disgust (Amir et al., 2005; Darwin,

1872; Philippot & Douilliez, 2005; Rossignol, Anselme, Vermeulen, Philippot, & Campanella, 2007). Surprisingly, even a positive expression such as happiness is not as straightforwardly positive as one would expect. There is incidental evidence that socially anxious avoid happy stimuli because they may interpret them either as being laughed at or as communicational appeal (Heuer, Rinck, & Becker, 2007; Lange, Keijsers, Becker, & Rinck, 2008). In fact, all emotional expressions have a communication aspect and could therefore evoke fear in socially anxious individuals. Another reason for equivocal results in the field could derive from the employment of static facial expressions, as used in the expression decoding studies reviewed so far. They might provide only a limited understanding of biased processing of social cues in social anxiety disorder as they lack a certain degree of ecological validity: faces in real live are not static. In real life nonverbal signals usually are also far less intense than depicted in standardized prototypical facial expressions. Additionally, emotional expressions do change permanently during everyday social interaction and may often transmit ambiguous signals. Herein, speeded or delayed (false) recognition of (certain) emotional expressions can have its greatest impact on evaluations and subsequent behavior. With an elegant set-up Joormann and Gotlib (2006) strove to tackle some of the above mentioned shortcomings at once: they presented expressions slowly developing from neutral to emotional, and chose a variety of emotions to test content specificity in different participant groups (Major Depressive Disorder, Social Phobia, healthy controls). Joormann and Gotlib (2006) employed a morphed faces task comparable to that of Niedenthal, Bauer, Halberstadt, and Innes-Ker (2001; Niedenthal, Brauer, Robin, & Innes-Ker, 2002) to assess in how far individual differences could account for discrepancies in (early) recognition and

labeling of emotional faces. They asked participants to watch a series of black and white “film clips” (individual photos in fast succession) showing facial expressions gradually changing from neutral to emotional (happiness, anger, fear, sadness), and stop its progression as soon as they believed that they could identify the emerging emotion. At that point emotional intensity as well as the supposed label of the emotion were recorded.

In the present study, we sought to replicate and expand the findings from Joormann and Gotlib (2006) in a non-clinical socially anxious sample and contrast those results with non-anxious controls. In order to improve ecological validity even further, we adopted the morphed-faces approach but generated movies that did not consist of distinguishable (500ms) steps of intensities, and no intensity repetitions, either. Instead, the films (and the depicted change of emotional expression) progressed fluently, changing in 1%-steps from a neutral expression to a full emotional expression (happiness, anger, or disgust) of the same actor each. Our selection of facial expression was based on the fact that Joormann and Gotlib (2006) had found no proof that neither sadness nor fear was particularly related to social anxiety disorder. Instead they presented evidence that angry faces might be threatening for socially anxious individuals. Even though Joorman and Gotlib did not find any significant correlations between social anxiety and quick and correct identification of happy faces, we implemented “happy” nevertheless. It has recently been found that socially anxious individuals seemingly interpreted happy expressions as aversive and consequently avoided them (see also: Heuer et al., 2007; Lange et al., 2008; Roelofs et al., 2008). Additionally, we added disgust to the set of emotions. As stated earlier, disgust can readily be interpreted as depicting

contempt (Darwin, 1872; Philippot & Douilliez, 2005), and there is also preliminary evidence that especially socially anxious individuals tend to do so (Heuer, Rinck, and Becker, in preparation). Finally, we added a second task where socially anxious participants (SAs) and non-anxious controls (NACs) had the opportunity to scroll through the movies by sliding the progress bar of the presentation software back and forth without any time constrains. Again, they were asked to determine the turning point of the emotional expression as well as naming the emotion (depicted at the end of the movie). With this task we aimed at exploring if SAs do objectively determine the turning-point towards (certain) emotional faces earlier than NACs instead of jumping to a preliminary (biased) conclusion based on information confined by time constrains. Additionally, we were able to explore if participants recognize the depicted full-blown emotions at all.

First, based of the results of Joormann & Gotlib (2006), we hypothesized that, under time restrictions (restricted viewing task; RVT), a higher degree of social anxiety would be related to a correct and early identification of angry facial expressions. As social anxiety has been found to be associated with interpreting disgust as contempt, we also expect a correct early detection of disgust features. Additionally, we assume that, compared to NACs, SAs will label early traces of disgust faces more frequently as “contempt”. We expect no differences between the groups with regard to happy faces. For the free viewing task (FVT) we assume, that SAs determine the turning-point between neutral and angry but also disgust expression to be earlier visible than NACs. If any accuracy difficulties occur at all, we belief SAs to mistake the full-blown expressions of disgust as contempt.

## Method

*Participants.* Twenty-seven highly socially anxious participants (SA) and 30 non-anxious controls (NAC) were tested, all of them students at Radboud University Nijmegen, the Netherlands. Participants were selected on the basis of their anxiety subscale scores on the Liebowitz Social Anxiety Scale (here LSAS-A; Liebowitz, 1987; Mennin et al., 2002; Oakman, Van-Ameringen, Mancini, & Farvolden, 2003). The LSAS was found to be a reliable, valid measure of social anxiety (Heimberg et al., 1999). Cut-off scores were chosen such that participants belonged to the highest or lowest 10% of the distribution (LSAS-A > 27 for SAs and LSAS-A < 13 for NACs). All participants were female.

Prior to the experiments, participants gave informed consent. Then they completed the LSAS a second time. In addition, participants answered the Fear of Negative Evaluation Scale (FNE; Duke et al., 2006; Leary, 1983), the Beck Depression Inventory (BDI; Beck et al., 1961), and the STAI-Trait questionnaire (STAI-T; Spielberger et al., 1983). The STAI-State (Spielberger et al., 1983) was filled in both before and after the experiments. After the experiments they received course credit or a modest fee for participating.

Table 4.1 shows the groups' mean questionnaire scores. SAs scored significantly higher than NACs not only on all LSAS-values, but also on the STAI-Trait and on the pre- and post-experimental measures of the STAI-State, indicating social anxiety and a higher level of state and trait anxiety in the socially anxious participants. The difference in BDI was also statistically significant, but of little practical relevance: for both groups, mean scores were in the low-to-normal range.

*Apparatus.* The tasks were conducted on a computer with Intel Pentium III processor, operating at 451 MHz on Windows XP Professional (2000) with 256 MB working memory. The connected monitor-type was “Vision Master Pro 410” from Iiama Electric Cooperation. While the restricted viewing task was run with the

**Table 4.1** *Means (M), standard deviations (SD), and t-tests of questionnaire scores for Socially Anxious (SA) and Non-Anxious Control (NAC) participants: Age, Liebowitz Social Anxiety Scale (LSAS-Sum) and Anxiety-subscale scores (LSAS-A); Fear of Negative Evaluation (FNE); state versions of the Spielberger State/Trait Anxiety Inventory before (STAI-$S_{pre}$) and after (STAI-$S_{post}$) the computer tasks; trait version of the Spielberger State/Trait Anxiety Inventory (STAI-T); Beck Depression Inventory (BDI)*

| | Group | | | |
|---|---|---|---|---|
| | SA (*n*=27) | | NAC (*n*=30) | |
| Questionnaires | *M* | *SD* | *M* | *SD* |
| Age | 20.00 | 2.50 | 20.03 | 2.04 |
| LSAS-Sum* | 65.37 | 14.93 | 16.77 | 8.15 |
| LSAS-A* | 35.52 | 6.66 | 8.87 | 3.95 |
| FNE* | 22.37 | 4.90 | 5.67 | 5.62 |
| STAI-$S_{pre}$* | 44.00 | 9.38 | 28.70 | 5.37 |
| STAI-$S_{post}$* | 45.15 | 9.57 | 33.23 | 8.23 |
| STAI-T* | 47.96 | 8.60 | 30.67 | 5.93 |
| BDI * | 10.63 | 6.61 | 3.67 | 3.61 |

*$p < 0.001$, two-tailed.

experimental software Presentation® (Neuralbehavioral Systems - NBS, 2003), the individual clips for the free viewing task were presented with Microsoft’s Windows Media Player (Version 64.09.1130).

*Stimuli.* Color pictures of 16 individuals (8 female), each one presenting four different expressions (angry, neutral, happy, and disgust) were taken from the Karolinska Directed Emotional Faces database (KDEF; Lundqvist et al., 1998). The size of the photos was 72,0 mm × 98,8 mm, 32-bit color. The computer software MorphX (Wenneberg, 2004) was used to produce movies ("morphing") depicting the transformation from the neutral photos to one of their expressional counterparts. Forty-eight 100-second movies resulted, which always started with a neutral expression of an individual actor and gradually (1%-steps) changed into one of the three other expressions. Thus, each individual appeared three times, changing in expression from neutral into either angry, smiling or disgust.

*Procedure.* Participants were seated approximately 50 cm from the computer monitor and completed the Restricted Viewing Task (RVT) first. They were informed that a total of 48 short movies would be presented to them on the computer screen in random order, each starting with a neutral expression, gradually changing into an emotional expression. The participants' task was to detect the developing emotion as soon as possible. Whenever they had the impression to have recognized the developing emotion they had to stop the movie by pressing the space bar. Subsequently, they had to decide which emotion they thought would be coming up at the end of the movie by pressing a marked number of the keyboard (1 = angry, 2 = contempt, 3 = disgust, 4 = happy). By key-press the next trial/movie started.

Due to program restrictions the order of the trials had to be pre-randomized and was manually corrected when the same emotions would have been shown more than three times in a row. The order was the same for all participants. The sequence of a trial was as follows: a blank, black screen appeared for 50 ms until the movie

started. Whenever the spacebar was pressed reaction times were recorded and a screen appeared recapitulating which key represented which emotion. When an appropriate button (1-4) was pressed, the response was recorded and the next trial started

For the FVT participants were informed that they would see the same 48 movies that they had seen before. This time they were encouraged to use the progress-bar of the media player to advance/scroll through the whole movie at their own speed, and by doing so determine the point when they thought the first sign of expression change was detectable. The elapsed time of the chosen frame was recorded. Afterwards, participants were asked to have another look at the end expression of the movie and guess which emotion it represents. As participants were encouraged to explore the films at their own speed without restrictions, we felt that the time they needed to complete a whole trial would not bear any extra information. Therefore, it was not recorded. The next movie-file was opened according to a pre-randomized list, until all movies were processed.

*Design.* For both tasks, first mean decoding accuracy scores across emotions for every participant were analyzed (with an ANOVA) by a 2 (group: SA, NAC) × 3 (emotion: angry, disgust, smiling) design. To explore error rates in more detail, emotions were analyzed separately yielding three 2 (group: SA, NAC) × 3 (incorrect response: angry - disgust, contempt, smiling; disgust – angry, contempt, smiling; smiling - angry, disgust, contempt) designs. Please note that contempt is an artificial response category, which indeed was not shown in the movies but offered as response option. Further, two 2 (group: SA, NAC) × 3 (morphed emotions: angry,

disgust, smiling) analyses of mean turning points were conducted for both tasks. While group was a between-subjects factor, morphed emotion and incorrect response were within-subjects factors.

## Results

*Restricted Viewing Task (RVT)*

*Decoding Accuracy.* First, mean response accuracy scores across morphed emotions (angry, disgust, smiling) were computed for every participant. The analysis revealed a highly significant main effect of morphed emotion, $F(2, 110) = 181$; $p = .00$; $eta^2 = .77$. As Figure 4.1 illustrates, this effect results from participants

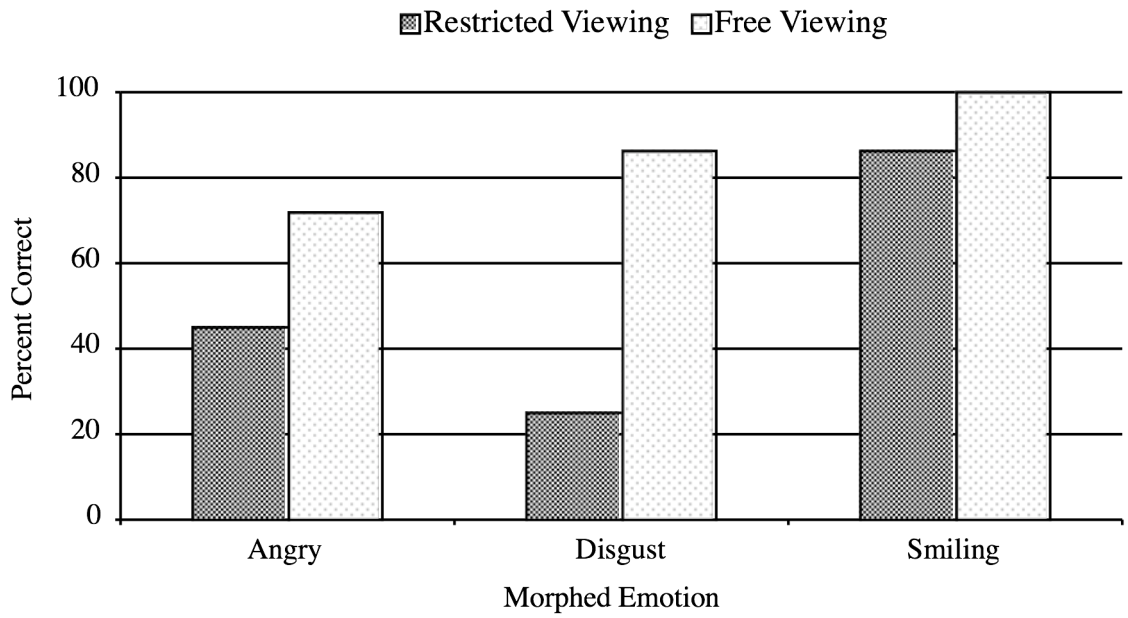


**Figure 4.1** *Restricted Viewing Task (RVT) and Free Viewing Task (FVT), mean percentage of correct responses per morphed emotion.*

identifying first signs of smiling faces more accurate (86%) than of angry faces (45%) and of disgust faces (25%), with all $p$'s < .01. Neither the main effect of group, $F(1, 54) = 0.00$; $p = .99$; $eta^2 = .00$, nor the interaction of group and morphed emotion,

$F(2, 110) = 0.93$; $p = .39$; $eta^2 = .02$, approached statistical significance.

To explore the high error rates for disgust movies in more detail, they were analyzed separately. Here, the analysis yielded a highly reliable main effect of incorrect response, $F(2, 110) = 112{,}84$; $p < .01$; $eta^2 = .67$, with contempt (50%) being the most frequent misinterpretation followed by angry (18%) and smiling (7%). Most interestingly, the interaction group and incorrect response was significant, $F(2, 110) = 3.47$; $p < .05$; $eta^2 = .06$. Subsequent *t*-tests evidence that compared to NACs, SAs show a statistical tendency to misinterpreted first signs of disgust as contempt (NAC = 45%, HAS = 56%; $p = .06$), whereas NAC showed a positive interpretation bias for first signs of disgust towards smiling (NAC = 9%, HAS = 4%; $p < .05$; Figure 4.2a). Similar analyses of error types in response to angry and smiling faces did not yield any significant interaction.

*Turning points.* When mean turning points of responses across emotions (angry, disgust, smiling) and participants were analyzed, the main effect of group was marginally significant, $F(1, 55) = 3.28$; $p = .08$; $eta^2 = .06$: SAs decided generally later (37 sec) than NACs (30 sec) when the emotion changed (Figure 4.2b). The interaction of group and morphed emotion was not statistically significant, $F(2, 110) = .33$; $p = .72$; $eta^2 = .01$. The main effect of morphed emotion, however was clearly significant, $F(2, 110) = 39.16$; $p < .01$; $eta^2 = .42$. Participants defined the turning point for smiling (29 sec) earlier than for disgust (32 sec) and for angry (39 sec), all *p*'s < .01.

In sum, groups did not differ in the relatively high error rates of 75% when seeing first signs of disgust, but interestingly differed in the type of misinterpretation

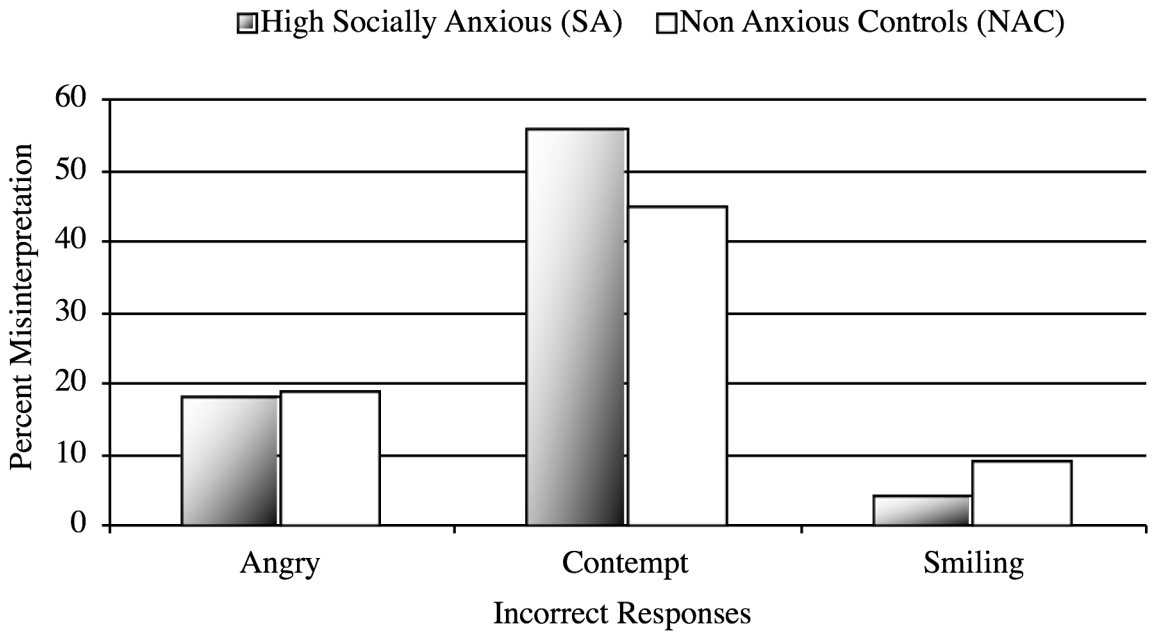


**Figure 4.2a** *Restricted Viewing Task (RVT), mean percentage of misinterpretations of disgust movies per group.*

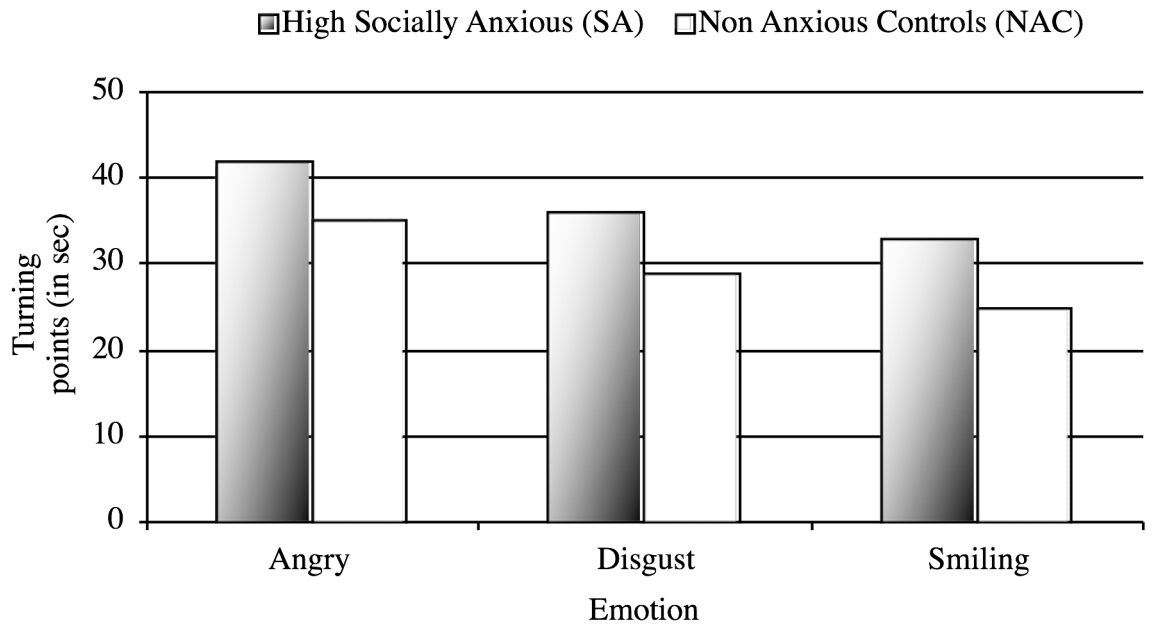


**Figure 4.2b** *Restricted Viewing Task (RVT), mean of turning points in seconds per morphed emotions per group.*

they made. SAs tended to interpretation the first signs as depicting contempt whereas NACs interpreted them as smiling. This was true although response latencies for decisions on disgust movies were equally long in both groups.

*Free Viewing Task (FVT)*

*Decoding Accuracy.* First, mean response accuracy scores for the full-blown emotions expressed at the end of the film (angry, disgust, smiling) were computed for every participant. The analysis revealed a highly significant main effect of emotion, $F(2, 108) = 77.81$; $p < .01$; $eta^2 = .59$. As Figure 4.1 illustrates, this effect results from participants identifying smiling faces more accurate (100%) than disgust faces (86%) and angry faces (72%), with all $p$'s < .01. Neither the main effect of group, $F(1, 54) = 0.00$; $p = .99$; $eta^2 = .00$, nor the interaction of group and emotion, $F(2, 108) = 1.62$; $p = .2$; $eta^2 = .03$, approached statistical significance.

To explore the high error rates for the stimulus with most errors in detail, responses to anger movies were analyzed separately. The analysis yielded a highly reliable main effect of incorrect response, $F(2, 108) = 135.28$; $p < .01$; $eta^2 = .71$, but no group differences or interaction of group and incorrect response. Participants of both groups thought the angry expressions at the end of the movie more frequently to depict contempt (21%) rather than disgust (7%). Errors in categorizing the final expression in disgust movies were analyzed in the same way. Here, the analysis revealed a highly significant main effect of incorrect response, too, $F(2, 108) = 35.59$; $p < .01$; $eta^2 = .39$. For all participants the percentage of a contempt interpretation (10%) was significantly higher than of an angry interpretation (2%). However, no main effect of group or group × incorrect response interaction was evident.

*Turning points.* Analysis of the mean turning points neither revealed a main effect of group, $F(1, 54) = 0.11$; $p = .74$; $eta^2 = .00$, nor was the interaction of group and morphed emotion statistically significant, $F(2, 108) = 0.72$; $p = .49$; $eta^2 = .01$. The main effect of morphed emotion, however, was clearly significant, $F(2, 108) = 68.53$; $p < .01$; $eta^2 = .56$. Participants defined the turning point for smiling movies (37 sec) earlier than for disgust (44 sec) and for angry movies (51 sec), all *p*'s < .01.

In sum, error rates for angry, smiling and disgust expressions were comparable for SAs and NACs. With 28%, error rates were generally highest for angry, although, compared to disgust and smiling, the turning point decision concerning angry movies was made at the latest. Moreover, contempt evidenced to be the most frequent misinterpretation for angry (21%) as well as for disgust expressions (10%).

## General Discussion

The present study investigated the role of social anxiety in speed and accuracy of facial emotion categorization in tasks where emotional intensity gradually developed out of a neutral expression. The findings from the RVT supported our hypotheses only to a limited extend. Unlike Joormann and Gotlib (2006; but also: Mohlman et al., 2007; Simonian et al., 2001) we did not find an enhanced accuracy when SA categorized first signs of angry faces, neither did SA need less intensity to do so. There was no evidence for a speeded identification nor a delayed identification (Montagne et al., 2006) of angry faces. Our hypothesis concerning speed and accuracy of disgust categorization were not supported, either: Both groups were equally fast and accurate at identifying first signs of disgust. Participants generally

identified first signs of smiling faces more accurate than signs of angry faces. Especially for first signs of disgust error rates were particularly high (75%). However, when errors where made SA categorized first signs of disgust as contempt congruent to their fears (Beck, 1976), while NACs showed a clear positive interpretation bias and interpreted these signs as first traces of happiness (Lundh & Ost, 1996; Mohlman et al., 2007; Pishyar et al., 2004). These results contribute to scarce experimental evidence of the particular role that disgust might play in socially anxious individuals (Amir et al., 2005; Rossignol et al., 2007; Schofield et al., 2007). In addition to the emotion-specific results, social anxiety was tendentiously related to delayed identification of first signs of emotional facial expressions in general.

Consistent with previous studies (Kolassa & Miltner, 2006; Philippot & Douilliez, 2005) results of the FVT indicate no accuracy differences between SAs and NACs when decoding full-blown emotional facial expressions (anger, disgust and smiling) without time constrains. In contrast to our results from the RVT, SA did not tend to interpret disgust expressions as contempt (for conflicting results see: Heuer, Rinck, and Becker, in preparation).

In general, happy expressions yielded the most accurate interpretation, followed by disgust and anger (compare: Philippot & Douilliez, 2005). In this task, anger seemed to be the most difficult emotion to decode.

The results from the turning point analyses support the decoding accuracy results. Groups did not show any differences in determining the point where first signs of an emotion became visible. In general, happy was recognizable relatively early, with only subtle differences from neutral, followed by disgust and angry facial expressions.

This study was designed as an extension of Joormann and Gotlib's (2006) experiment who used a morphed film paradigm in order to increase ecologic validity of expression identification tasks. Participants were asked to determine the point where the first signs of a gradually developing emotional expression became apparent and categorize the (first signs of) expression they had seen. Along with Joormann and Gotlib we argued that in everyday life people generally encounter different intensities of facial expressions. Confrontations with full-blown static expressions as often implemented in experimental research are rather unusual. Cognitive models of social phobia supposed that disruptions in the correct and speeded identification of facial expressions even at low emotional intensities can hamper social interaction and appropriate social behavior considerably and may consequently maintain or increase social anxiety (Clark & Wells, 1995; Rapee & Heimberg, 1997; Stopa & Clark, 1993). Our results indicate that socially anxious participants, when in doubt tend to interpret signs of disgust as contempt. This is in also line with the assumption that socially anxious individuals tend to interpret ambiguous social cues as threatening (e.g., Rapee & Heimberg, 1997).

The discrepancy between our free and restricted viewing condition can possibly be attributed to different stages of processing. Reaction time based paradigms like the RVT are considered to measure more fast, automatic biases, whereas tasks without time constrains measure more strategic processes. Although we are aware, that by our RVT we did not measure automatic biases in a narrow sense, the present results lend partial support to the presumption of Philippot and Doulliez (2005). They assumed that, if at all, biased interpretation of emotional faces takes place at a more automatic rather than at a strategic level of processing.

Restricted response windows might in fact pressure the decision in a threat-congruent fashion, while free viewing allows more conscious elaboration (Mohlman et al., 2007). Results are also partially in line with recent cognitive models of anxiety in general, assuming the existence of cognitive subsystems, which evaluate the threat value of stimuli already at a level of pre-consciousness to give them priority in further processing (Mathews & Mackintosh, 1998; Mogg & Bradley, 1998; Öhman, 1993).

In contrast to studies pressuring participants to fast responses (Mohlman et al., 2007; Winton et al., 1995) the present RVT findings were not due to a general negativity bias, the inferences were rather specific. In fact it is possible that disgust is the most ambiguous of the employed emotions in these tasks. Philippot and Douilliez (2005), and also Darwin (1872) stressed the close relationship between disgust and contempt and their possible link with social rejection. As cognitive models of social phobia suggest that social anxiety is related to a tendency to interpret ambiguous social information as negative or even socially threatening (Clark & Wells, 1995; Rapee & Heimberg, 1997) it is plausible to assume that our results hint at such a process. Studies not including this response category failed to find any decoding biases for disgust for unlimited as well as limited response windows (Philippot & Douilliez, 2005; Schofield et al., 2007).

In sum, this study did not support the notion that socially anxious individuals are exceedingly good/fast at identifying emotional expressions in others (for conflicting results see: Joormann & Gotlib, 2006). Additionally, they do not lack the skill to correctly recognize emotional facial expressions as might be deduced from the social skills deficit model (Alden & Wallace, 1995; Ashbaugh, Antony, McCabe,

Schmidt, & Swinson, 2005; Foa et al., 2001). It is more likely that a continuous valence evaluation/interpretation mechanism (Mogg & Bradley, 1998) slightly slows emotion categorization of SAs in a performance situation as evidenced by the tendentiously slowed responding in SA. Mogg and Bradley (1998) suggested that such a mechanism is fine-tuned by genetic setup as well as past experiences and cognitive set. This mechanism may be responsible for a misinterpretation of disgust features as contempt. However, evidence for misinterpretation or negative evaluation of facial expression is equivocal so far (e.g., Merckelbach, Van Hout et al., 1989). If reported, distortions seem to be rather elicited under conditions of restricted processing (e.g., short presentation times, restricted response window, etc.) but not under conditions of free processing (e.g., Philippot & Douilliez, 2005). There is even less evidence for a structural misinterpretation of disgust as contempt.

As mentioned above, our results contradict those of Joormann & Gotlib (2006). With a comparable experimental design, they found that social phobic individuals were considerably faster in identifying developing angry expressions than were depressed participants or normal controls. It is difficult to explain those differences in findings. Despite the similarities between the two approaches, there are, numerous methodological difference that could have led to the divergent results. Most prominently, the depicted change in our movies was much more gradual/slower (1 vs 2 % steps), thus more difficult to detect, and we had no emotion repeated by the same actor. When comparing the error rates as well as RTs of the two studies, it appears as if our task was much more difficult than that of Joormann & Gotlib (2006). In the RVT for example participants recognized angry faces in 45% of the trials, and happy expressions in 86%. In Joormann and Gotlib's (2006) study the percentage

correct rates were much higher for these expressions (anger: 79%; happy: 98%). Disgust was in our study recognized correctly in only 25% of the trials. In the FVT participants had great difficulty in identifying angry facial expressions (72%, happy 100% and disgust 86% correct). These figures could indicate a limitation concerning our stimulus material. As can be seen in Appendix 4.1, detailed analysis revealed that especially angry facial expressions vary largely in quality. Four of the anger pictures even led to more frequent false interpretations than correct ones. If emotions are indeed not clearly distinguishable they do definitely make the task more difficult. Another hint at enhanced task difficulty may be that, even when correcting for the uneven length of the stimulus films, participants generally reacted faster in the Joormann and Gotlib's (2006) study.

Kamachi, Bruce, Mukaida, et al. (2001) found that identification accuracy of facial expressions was highly dependent on the speed of the sequence: Happiness and to some extend surprise were categorized most accurately with a fast changing sequence, while anger required medium, and sadness slow changing displays. It is possible that the speed of change is related to the developing speed of an expression in "real-life". Consequently, it would be plausible to assume that biases only show if the displays progress realistically, and that speed of change has to be different for the different emotions. If that is true, the occurrence of a particular bias might be proof that the speed of a particular expression film "accidentally" coincided with the most ideal sequence speed for that specific emotion.

Additionally, we have to be aware, that using "contempt" as additional response option is critical. As an artificial category it facilitates response biases and it would have been more elegant, for example, to have as many positive as negative

response options. However, both groups could have chosen anger, too, but they did not.

A final point of concern is the participant selection. We are aware that results obtained by sampling sub-clinical socially anxious individuals do only allow limited generalization to a socially phobic population. However, as the transition between non-clinical and clinical social anxiety is thought to be of rather quantitative nature (Rapee & Heimberg, 1997), we felt that an analogue sample can nevertheless help to shed light on the mechanisms active in a clinical population. Due to the constitution of the student population tested, it was only possible to test female participants. Of course it will be necessary to replicate our findings with a mixed-gender group.

In absence of comparable experimental data in the literature, however, we have to conclude that under conditions of slow emotional change, participants do not show individual differences with regard to recognition speed or accuracy when identifying displays of facial expressions changing from neutral to happy, angry or disgust. Our results do imply that constrictions of the processing itself (time pressure in the Restricted Viewing Task), difficulty of the task (very slow change) resulted in an artificial increase of ambiguity and hence facilitated the misinterpretation of the already ambiguous expression of disgust in SA.

Given the results of the current study, but also those of Joormann and Gotlib (2006), it seems worthwhile to develop the morphing task further, for in depth analysis of deficits or biases in the recognition of emotional facial expressions in social phobia. A whole range of emotions needs to be evaluated, to test the specificity of the biases. The speed of the changing sequence might need to be

adjusted for each emotion separately (Kamachi et al., 2001). It would also be worthwhile to explore the identification of the off-set of an emotion, starting with a full-blown expression changing into neutral (compare: Niedenthal, Halberstadt, Margolin, & Innes-Ker, 2000).

In conclusion, it has been shown that socially anxious individuals, but only when under pressure potentially interpret disgust as contempt. As afore mentioned, the quick and correct identification of facial expressions is crucial for inferring the state of mind of others and for consequently adjusting one's own behavior appropriately. The tendency to interpret an ambiguous facial expression as disgust in a threat confirming way is likely to enhance social anxiety, trigger inappropriate social and communication behavior, lead to avoidance of social situations and thus maintenance of the disorder.

**Appendix 4.1** *Percentages of emotions "seen" in the Free Viewing Task, separately for each picture presented. Correct interpretations are indicated in bold*

| Picture code | Picture emotion | Emotion seen | | | |
|---|---|---|---|---|---|
| | | Angry | Contempt | Disgust | Happy |
| F07 | Angry | **95.1%** | 4.9% | | |
| F07 | Disgust | | 50.8% | **49.2%** | |
| F07 | Happy | | | | **100.0%** |
| F09 | Angry | **82.0%** | 18.0% | | |
| F09 | Disgust | | 3.3% | **96.7%** | |
| F09 | Happy | | | | **100.0%** |
| F14 | Angry | **98.4%** | 1.6% | | |
| F14 | Disgust | 1.6% | 6.6% | **91.8%** | |
| F14 | Happy | | | | **100.0%** |
| F17 | Angry | **60.7%** | 21.3% | 18.0% | |
| F17 | Disgust | | 6.6% | **93.4%** | |
| F17 | Happy | | | | **100.0%** |
| F20 | Angry | **96.7%** | 3.3% | | |
| F20 | Disgust | | 9.8% | **90.2%** | |
| F20 | Happy | | | | **100.0%** |
| F24 | Angry | **21.3%** | 63.9% | 13.1% | |
| F24 | Disgust | 3.3% | 4.9% | **91.8%** | |
| F24 | Happy | | 3.3% | | **96.7%** |
| F26 | Angry | **85.2%** | 14.8% | | |
| F26 | Disgust | 1.6% | 3.3% | **95.1%** | |
| F26 | Happy | | | | **100.0%** |
| F29 | Angry | **32.8%** | 62.3% | 3.3% | |
| F29 | Disgust | | 24.6% | **75.4%** | |
| F29 | Happy | | | | **100.0%** |
| M01 | Angry | **41.0%** | 57.4% | 1.6% | |
| M01 | Disgust | | 3.3% | **95.1%** | |
| M01 | Happy | | | | **100.0%** |
| M02 | Angry | **93.4%** | 6.6% | | |
| M02 | Disgust | | 19.7% | **80.3%** | |
| M02 | Happy | | | | **100.0%** |
| M04 | Angry | **26.2%** | 49.2% | 24.6% | |
| M04 | Disgust | | 4.9% | **91.8%** | |
| M04 | Happy | | | | **100.0%** |
| M06 | Angry | **86.9%** | 13.1% | | |
| M06 | Disgust | | 13.1% | **86.9%** | |
| M06 | Happy | | | | **100.0%** |
| M10 | Angry | **98.4%** | 1.6% | | |
| M10 | Disgust | 19.7% | 4.9% | **75.4%** | |
| M10 | Happy | | | | **100.0%** |
| M12 | Angry | **45.9%** | 13.1% | 41.0% | |
| M12 | Disgust | | 6.6% | **91.8%** | 1.6% |
| M12 | Happy | | | | **100.0%** |
| M28 | Angry | **96.7%** | | 3.3% | |
| M28 | Disgust | 3.3% | 19.7% | **77.0%** | |
| M28 | Happy | | 1.6% | | **98.4%** |
| M34 | Angry | **98.4%** | 1.6% | | |
| M34 | Disgust | 3.3% | 1.6% | **95.1%** | |
| M34 | Happy | | 1.6% | | **98.4%** |

*Note.* The picture codes correspond to those used in the KDEF database. Due to missing data some percentages do not sum up to 100%.

Chapter 5

# Here's looking at you, folks: Eye Movement and the Evaluation of Facial Crowds in Social Anxiety

This chapter is submitted as: Lange, W.-G., Heuer, K., Langner, O., Keijsers, G.P.J., Rinck, M., & Becker, E.S. (2008). Here's looking at you, folks: Eye movement and the evaluation of facial crowds in social anxiety.

## Abstract

Scientific evidence is equivocal on whether Social Anxiety Disorder is characterized by a biased negative evaluation of (grouped) facial expressions. Twenty-two highly socially anxious (SAs) and 21 non-anxious controls (NACs) rated the degree of friendliness of different neutral-angry and happy-angry face combinations while eye movements were recorded. The resultant eye-movement patterns revealed that SAs, compared to NACs looked away faster when the first fixated face was angry. Additionally, the proportion of fixated angry faces was significantly higher than for other expressions in SAs. In general, these fixated angry faces were the best predictor of subsequent affect ratings for either group, independent of social anxiety. The rating task data, however, revealed no significant differences between SAs and NACs.

## Introduction

It has repeatedly been suggested that attentional and interpretation biases in patients diagnosed with social anxiety disorder (or social phobia; for diagnostic details see: American Psychiatric Association, 2000; APA) expedite the maintenance of this disorder (Beck & Clark, 1997; Clark & Wells, 1995; Foa, Franklin, Perry, & Herbert, 1996; Heinrichs & Hofmann, 2001; Hirsch & Clark, 2004; Rapee & Heimberg, 1997; Stopa & Clark, 1993). Negative evaluation by others lies at the core of what socially anxious individuals (SAs) fear the most.

While negative biases in interpretation and evaluation of social situations (negative interpretation biases) in SA are frequently found using text vignettes of ambiguous social scenarios (Amir, Foa, & Coles, 1998; Brendle & Wenzel, 2004; Hirsch & Clark, 2004; Huppert, Foa, Furr, Filip, & Mathews, 2003; Stopa & Clark, 2000; Voncken, Bögels, & de Vries, 2003), evidence is less persuasive from tasks where participants evaluate facial expressions. The importance of facial expressions for social interaction and communication, and the fact that the same expressions can be interpreted in different ways makes it extremely surprising that SAs do not consistently process/evaluate facial expressions differently from non-anxious controls (NACs). Some support for this notion comes from Abrams (1999) and Surcinelli, Codispoti Montebarocci, et al. (2006). They have found that participants high in (social) anxiety show a recognition bias for negative facial expressions. Gilboa-Schechtman, Presburger, Marom & Hermesh (2005) have argued that the co-occurrence of different facial expression in a group faces enhances ambiguity and makes it more succeptible for biased interpretation. Additionally, groups are

supposed to evoke even more social anxiety than one-by-one encounters. Utilizing displays of facial crowds, they could show that patients with generalized Social Anxiety Disorder (Social Phobia) have a tendency to evaluate moderately disapproving crowds more negatively compared to non-clinical controls. Individuals with social anxiety and comorbid depression evaluated extremely disapproving crowds more negatively. Results from Winton, Clark, and Edelmanns (1995), however, are more equivocal. They reported a tendency of SA to rate facial expressions as negative (Experiment 2), but did not find an enhanced ability in socially anxious participants for detecting negative emotions (Experiment 1). No support for processing biases for facial expressions in SA came from Douilliez and Philippot (2003; Philippot & Douilliez, 2005) when they asked socially phobic participants, generally (not socially) anxious participants and non-anxious controls to judge how strongly different intensities of facial expressions portrayed different emotions. Merckelbach, Van Hout, Van den Hout, and Mersch (1989) did not find any evidence, either, that socially phobic participants do process angry faces differently than non-anxious controls. Finally, our previous work (Lange, Keijsers, Becker, & Rinck, 2008), did not substantiate any difference in ratings of a crowd's facial expressions related to degree of social anxiety. In an Approach-Avoidance Task (compare: Heuer, Rinck, & Becker, 2007; Rinck & Becker, 2007), however, SA displayed increased initial avoidance tendencies in response to crowds when the number of angry faces in a neutral crowd increased. Additionally, SAs also avoided smiling faces, even though these were task irrelevant.

The inconsistencies in the reported findings can partially explained by neurological hardwiring that is thought to underlie and facilitate rapid face processing

(Haxby, Hoffman, & Gobbini, 2000; Herrmann, Ehlis, Muehlberger, & Fallgatter, 2005; Vuilleumier, 2002, 2005). LeDoux (1996), for example, suggested that the processing of threat cues travels via two different neurological pathways: a subcortical route for rough, quick stimulus evaluation and response initiation, and a cortical and slow one for thorough evaluation of a stimulus. It is proposed that discrimination of danger-relevant stimuli, such as, e.g., angry faces, takes place pre-attentively and is evolutionarily beneficial (LeDoux, 1996; Öhman, 1993; Öhman & Soares, 1993). Consequently, it is conceivable that measures of conscious recognition and evaluation of facial expressions, as presented above, are not sensitive enough to detect possible processing biases. Automatic attentional processes and quick evaluation, as well as appropriate responses or behavior might be initiated or executed very early, leaving patients and researchers unaware of fast-acting automatic evaluation or associated responses.

Evidence from visual search tasks has strengthened the notion that threat is processed pre-attentively. Although the presentation of facial crowds should be particularly anxiety evoking in SA, reported findings cannot be conclusively integrated into our understanding of social anxiety. Öhman, Lundqvist, and Esteves (2001) for example have shown that *in general* angry faces are detected faster ("pop-out") in both neutral and happy crowds, while neutral and happy faces are not preferentially detected when embedded in angry crowds (see also: Fox et al., 2000; Tipples, Atkinson, & Young, 2002; Williams, Moss, Bradshaw, & Mattingley, 2005). Calvo, Avero, and Lunqvist (2006) recorded eye movements during a visual search task. The reported "anger superiority effect" could not be explained by a higher proportion of initial fixations on an angry face; instead, angry faces were detected

more accurately even though they were fixated upon less often and for a shorter time than other faces. Gilboa-Schechtman, Foa, and Amir (1999) found more rapid detection of angry faces compared to happy faces in neutral crowds; this finding was even more pronounced in participants diagnosed with Social Anxiety Disorder. Juth, Lundqvist, Karlsson, and Öhman (2005), however, found that SAs were distracted not only when looking for dissimilar faces amongst angry but also in happy crowds (Juth et al., 2005). In sum, it remains unclear whether angry faces are preferentially processed by SAs and whether such a processing biases distorts the subjective rating of particular facial expressions in SA and not in NACs.

In the present study, we aimed at exploring the relationship between (preferential) attentional processing, subjective ratings of affect in response to faces, and social anxiety. Crowd displays were considered the most fitting stimuli for this research because we would be able to present competing emotional stimuli so that attentional biases (here: eye-movements) with regard to certain stimulus categories could be assessed. Additionally, due to the combination of different facial expressions, we were free in manipulating the degree of threat by varying the ratio between neutral, angry, and smiling faces. Besides that, crowds are more ambiguous than individual photos, are more susceptible to interpretations and could consequently be more threatening to SAs - enhancing possible evaluative differences.

First, we examined whether (different aspects of) eye movements differed between SA and NACs when viewing facial crowds. Second, we explored how facial crowds would be rated with respect to perceived friendliness as the ratio of angry faces in a neutral crowd or angry faces in a smiling crowd varied. We wanted to

know whether these ratings would differ in SAs as compared to NACs. Third, to control for rapid, impulsive judgments as compared to delayed, deliberate judgments, crowds were presented for different presentation times (compare: Gilboa-Schechtman et al., 2005; Lange et al., 2008). Fourth and most importantly, we investigated whether eye movement patterns would predict subsequent ratings.

It was assumed that the number of angry faces shown in a group would influence gaze duration and number fixations on angry faces for SAs more than for NACs, and consequently subsequent ratings. This evaluation was expected to become increasingly negative as the number of angry faces increased in either a neutral or a happy crowd. In line with earlier research, we expect more negative ratings on moderately negative crowds in SAs than in NACs. Additionally, we expected these findings to be more pronounced in response to short as compared to long presentation times (Lange et al., 2008).

## Methods

*Participants, and Measures*

During prescreening, psychology students from the Dresden University of Technology filled in the German version of the Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987; Stangier & Heidenreich, in press) and were selected based on their scores on the LSAS anxiety subscale (< 13 or > 27). The initial group of 43 students (82.6% female) was subdivided into 22 Socially Anxious participants (SAs) and 21 Non-Anxious Controls (NACs). The experimental session lasted a total of 60 minutes. All participants received € 8,- or course credit for their participation.

After giving informed consent, participants filled in the state-version of the German State/Trait Anxiety Inventory (here: STAI-State1; Laux, Glanzmann, Schaffner, & Spielberger, 1981). Then participants completed the rating task and afterwards the STAI for a second time (STAI-State2), a general screening instrument for eyesight, handedness, education, and use of medication, a German translation of the “Inventory to diagnose depression” (Zimmerman, Coryell, Wilson, & Corenthal, 1986), the “Fragebogen zur Depressionsdiagnostik nach DSM-IV” (FDD-DSM-IV; Kühner, 1997), and the trait-version of the German STAI (STAI-Trait; Laux et al., 1981).

*Apparatus*

All stimuli were presented on a blue background on a 17-inch monitor (85 Hz) with a screen resolution of 1024 × 768. Eye movements were recorded using an “EyeLink V2.01” tracking system (SR Research Ltd., Toronto) at a sample rate of 250 Hz as participants inspected and rated the facial displays.

*Materials*

Color photos of 16 male[1] individuals, showing three different expressions (angry, neutral and happy) was adapted from the Karolinska Directed Emotional Faces database (KDEF; Lundqvist, Flykt, & Öhman, 1998). Photos were resized to 34 × 165 pixels. Subsequently, matrices of 16 (4×4) facial expressions were constructed, with each individual appearing exactly once per matrix. Two types of crowds were created: Neutral-angry and happy-angry combinations (compare: Gilboa-Schechtman et al., 2005). The degree of socio evaluative threat for each grouping

was varied by gradually increasing the ratio of angry faces in each crowd. This resulted in seven different ratios: 14:2 (e.g., 14 neutral and two angry pictures), 12:4, 10:6, 8:8, 6:10, 4:11, and 2:14 (see Figure 5.1). Each individual and emotional expression was randomly presented at any position. The 16 pictures were evenly spread across a rectangle of 590 × 762 pixels, with margins of 122 pixels left and right, and 3 pixels above and below the pictures.

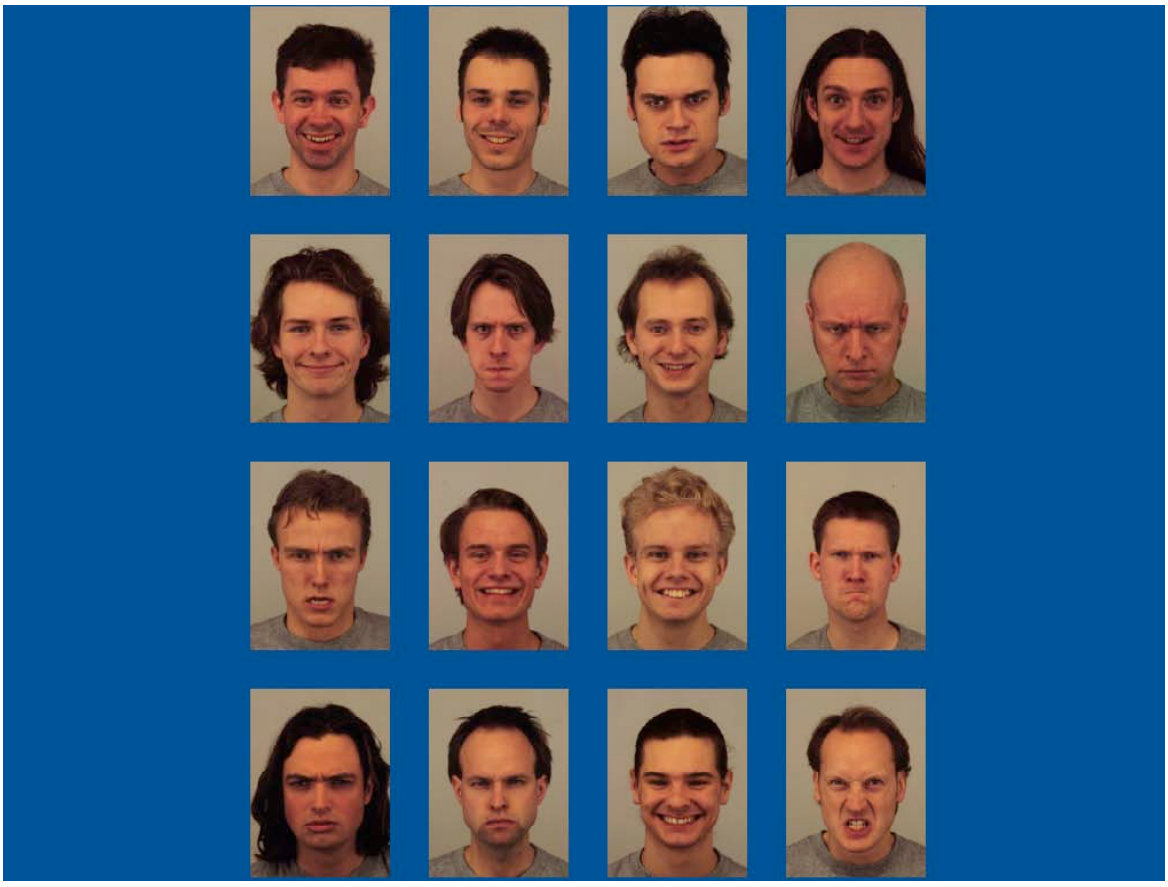

**Figure 5.1** *Example of a stimulus display.*

*Procedure*

After calibration (repeated every 10th trial) and validation of the eye tracking system, the computer program was started and instructions appeared on the screen. Participants were given 36 practice trials to become acquainted to the use of the –3, –2, –1, +1, +2, +3 marked keys of a standard computer keyboard. Participants practiced pressing the six keys with the ring, middle and index fingers of the left and right hand, allowing evaluation the face matrices without needing to reposition their fingers or looking away from the screen later in the experiment. Twenty-eight practice trials were then completed with different, female crowds of each crowd type. Participants were instructed to subjectively judge how (un-)friendly they found each presented crowd after seeing it for either 500 or 2500 ms using the keys described above. The number of experimental trials was divided into three blocks to allow for pauses in-between. Presentation times and other independent variables (crowd type, ratio) were randomized within and between blocks. The trial order within each block, as well as block order were pre-randomized and iterated for every 4th participant. In the main experiment, participants completed 3 sets of 140 trials each. Trials were divided equally into 15 trials per crowd type, ratio, and presentation time (i.e. 15 × 2 × 7 × 2 = 420). Each individual appeared at random in one of the 16 matrix positions.

In each trial, a yellow, centered fixation cross was initially displayed in the center of a blue screen for 1000 ms. Then the crowd stimulus was presented for either 500 or 2500 ms, after which an empty blue screen appeared. The blank screen remained visible until the participant reacted or until 2000 ms had elapsed, and was followed by an intertrial interval of 500 ms. In addition to ratings and

reaction times, the following eye tracking variables were measured: Duration and location of initial fixation as well as order and gaze duration for every subsequently fixated picture.

*Design*

A 2 (crowd type: neutral-angry, happy-angry) × 7 (expression ratio: 14:2, 12:4, 10:6, 8:8, 6:10, 4:11, 2:14)$^2$ × 2 (presentation time: 500, 2500) × 2 (social anxiety: low, high) factorial design was used in analyzing the subjective ratings, decision latencies, and eye tracking data. While degree of anxiety was used as between-subjects factor, crowd type, ratio (of pictures in the center), and presentation time were within-subjects factors. Since participants were instructed to fixate their gaze to the center of the screen before each trial, we expected that the central four pictures would appear more prominent than those in the periphery. In order to control for this likelihood, the central four images and related expression ratios therein were indexed so that separate data analyses could be calculated.

## Results

*Questionnaires.* The participant groups scored markedly different on anxiety related concepts such as state- and trait anxiety. Additionally, SAs scored significantly higher on the depression scale than did the NACs. However, all scores fell within a normal, non-pathological range (for means see: Table 5.1).

*Ratings.* Happy-angry crowds ($M$ = 0.29; $SD$ = 0.41) were rated more positively than neutral-angry crowds ($M$ = -1.26; $SD$ = 0.45), $F(1, 41) = 325.03$ , MSE = 2.23 , $p <$ .001 across all ratios. There was a significant main effect of ratio, $F(6, 246) = 389.60$,

**Table 5.1** *Means (M) and standard deviations (SD) age and questionnaire scores for socially anxious participants (SAs) and non-anxious controls (NACs): Liebowitz Social Anxiety Scale - anxiety subscale (LSAS-anxiety), the state version of the Spielberger State/Trait Anxiety Inventory before and after the experiment (STAI-State1 & State2), the trait version of the Spielberger State/Trait Anxiety Inventory (STAI-Trait), and the "Fragebogen zur Depressionsdiagnostik (FDD)"*

| | Group | | | |
|---|---|---|---|---|
| | SA (*n*=22) | | NAC (*n*=21) | |
| Variables | *M* | *SD* | *M* | *SD* |
| Age | 24.2 | 4.1 | 23.6 | 3.9 |
| LSAS-anxiety** | 37.6 | 8.9 | 8.9 | 3.6 |
| STAI-Trait** | 46.5 | 8.9 | 33.6 | 7.1 |
| STAI-State1** | 41.3 | 7.1 | 33.0 | 7.0 |
| STAI-State2* | 46.8 | 10.0 | 36.1 | 9.0 |
| FDD** | 11.8 | 6.3 | 4.3 | 4.2 |

*$p < .01$, two-tailed. **$p < .001$, two-tailed.

MSE = 0.14, $p < .001$ with ratings for both crowd types decreasing as additional angry faces are added (see Figure 5.2a, b). Ratings were generally more positive after seeing the crowd for 500 ms ($M$ = -0.43; $SD$ = 0.33) compared to ratings after 2500 ms ($M$ = -0.54; $SD$ = 0.34), $F(1, 41) = 15.27$, MSE = 0.20, $p < .001$. In contrast, the factor group did not reach statistical significance, $F(1, 41) < 1$, MSE = 3.01, $p = .58$; other relevant interaction with group were also non-significant. In sum, ratings of *both* groups declined with every additional angry face in the crowd. Since no interaction between group and crowd type occurred, analyses of the separate crowd types were omitted.

*Eye Movements.* In order to gain insight into the attentional mechanisms resulting in subjective rating of facial expression, a number of variables were computed from the raw eye-tracking data. These included: number of fixated (central) angry expressions, proportion of fixated angry faces of all fixations, proportion of angry

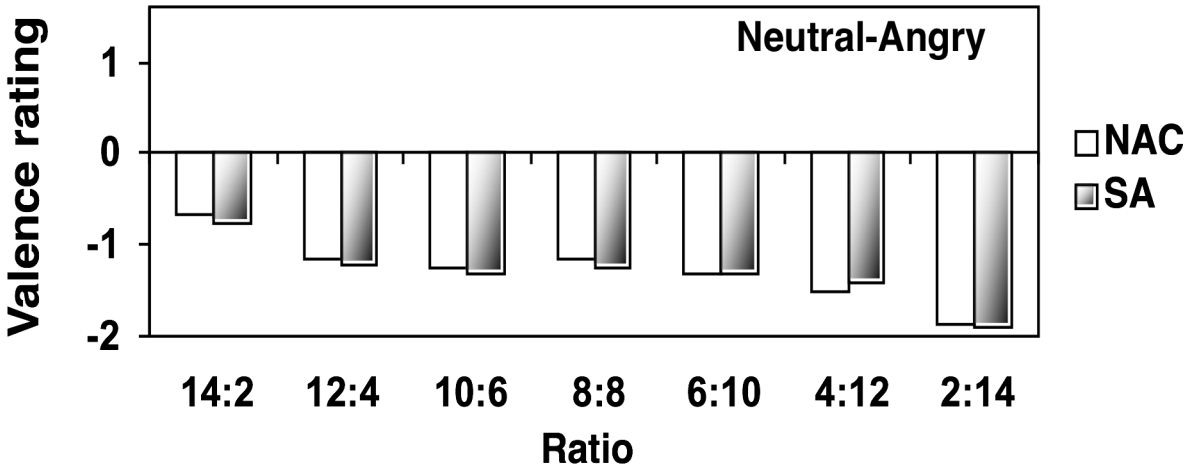


**Figure 5.2a** *Mean valence ratings for neutral-angry crowds per ratio and anxiety group.*

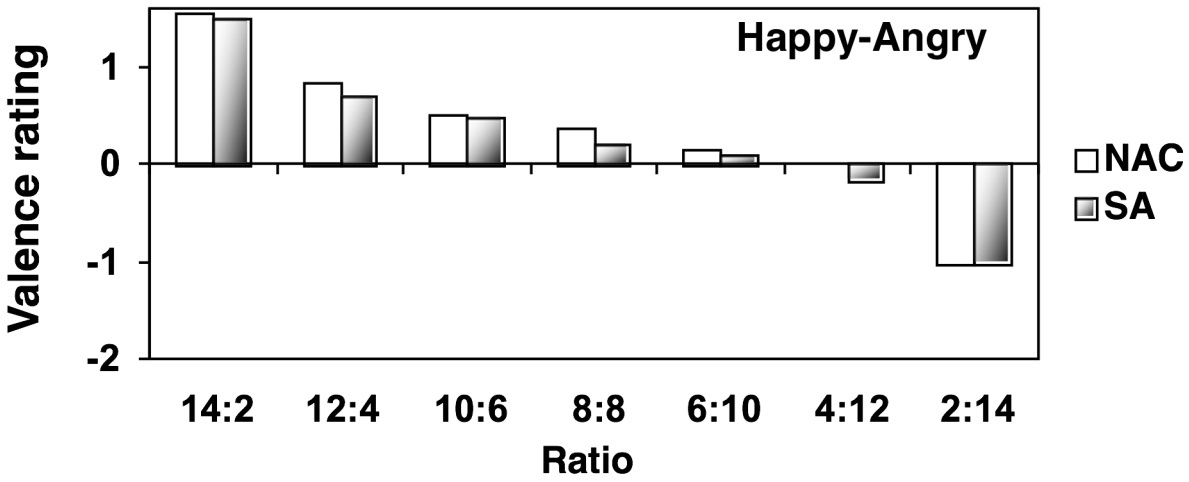


**Figure 5.2b** *Mean valence ratings for happy-angry crowds per ratio and anxiety group.*

faces on first fixation (in center), total gaze duration on angry faces, mean gaze duration on non-angry faces, and mean gaze duration on first fixated expression (compare: Table 5.2). To determine which eye-tracking variables could most reliably predict crowd ratings, correlations between these measures and friendliness ratings were calculated.

**Table 5.2** *Correlations (Person's r) between relevant independent variables, different facets of eye movement behavior and social anxiety, Ratings and Presentation Time (PT; n = 43)*

| | Anxiety | Rating | PT |
|---|---|---|---|
| Rating | .01 | | |
| Presentation Time | -.00 | -.29 | |
| Ratio | .00 | -.27 | .00 |
| No. angry faces among central four | .00 | -.42** | .00 |
| No. fixated angry faces without repetition | .02 | -.37* | .57* |
| No. fixated central angry faces | .02 | .40** | .30 |
| Proportion fixated angry from all fixated pictures | -.10 | -.51** | -.10 |
| Proportion angry on first fixation | -.01 | -.32* | .00 |
| Proportion angry on first fixation in center | -.01 | -.31* | -.00 |
| Total gaze duration on angry faces | -.01 | -.40** | .63** |
| Mean gaze duration on non-angry faces | .01 | .36* | .64** |
| Mean gaze duration on the face fixated first | -.01 | .01 | .41** |

*$p < .05$, two-tailed. **$p < .01$, two-tailed.

*Note.* Due to the pre-selection based on degree of social anxiety, correlations with this factor are artificially inflated.

Generally, most of the independent variables were not significantly relevant for interpretation. Presentation time, social anxiety, and even crowd expression ratios were, if at all, only moderately correlated with the ratings (Table 5.2). Herein, the number of angry faces in the four central images was the best predictor of friendliness ratings. When looking at the eye-movement data, it appeared that the

proportion of fixated angry faces among all fixated faces was the strongest predictor of subsequent rating. The rating of a crowd can only become negative once one has actually seen the negative faces composing it. Further, the absolute number of fixated angry faces (without repetitions), independent of the actual number of angry faces in the matrix, reliably influenced the way participants rated the crowds: the more angry faces fixated, the more negative the rating. The same finding applied to the number of fixated *central* angry faces. Similarly, the proportion of *first* fixations on an angry face, as well as the proportion of first fixations on an angry face among the *central four* pictures predicted ratings. Finally, increased total gaze duration on angry faces and mean gaze duration on non-angry faces influenced whether participants rated the crowds more negatively, or more positively, respectively (Table 5.2).

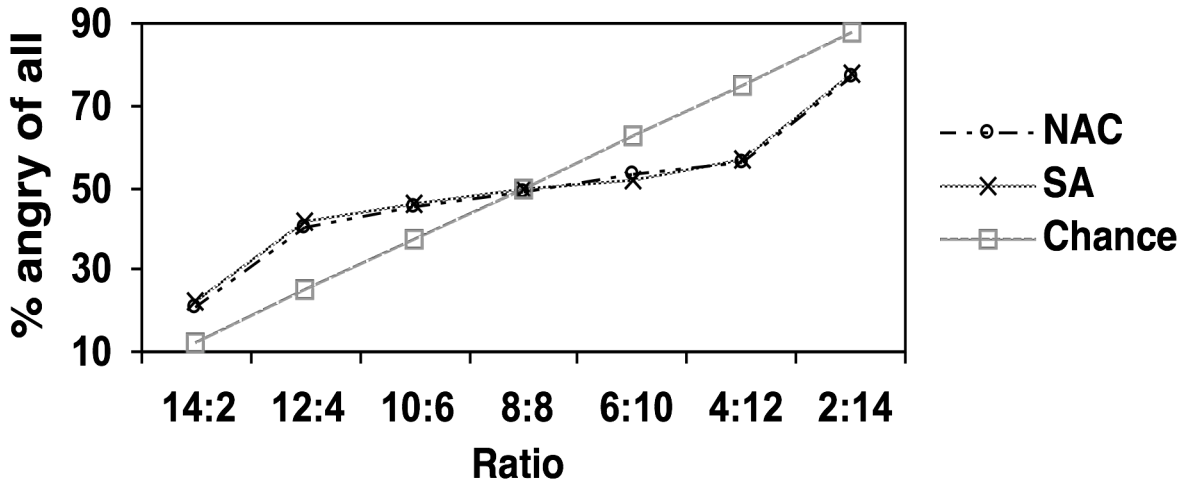


**Figure 5.3** *Percentage angry-fixations per group per ratio in comparison to real percentage angry faces.*

Strikingly, SAs ($M$ = 0.50, $SD$ = 0.008) had a slightly, yet consistently higher proportion angry faces fixated than NACs ($M$ = 0.49, $SD$ = 0.01), $F(1, 41) = 7.08$, MSE = 0.003; $p < .05$, independent of crowd type or presentation time (Figure 5.3).

On further inspection, it appears that the proportion of fixated angry faces does not match the actual percentage of angry faces present in the matrix. It seems as if the focus of all participants lay generally more towards the few incongruent pictures, on either end of the distribution. This phenomenon was independent of the expression being portrayed. Interestingly, eye movements and fixations did not reveal evidence of increased vigilance for angry faces in SAs: their first fixation was not more likely to be located on an angry face than those of NACs, $F(1, 41) < 1$, MSE = 26, $p = .33$. In contrast, when there was enough time for avoidance of angry faces, during the 2500 ms presentation time trials, SAs did show evidence of avoidance. When the first

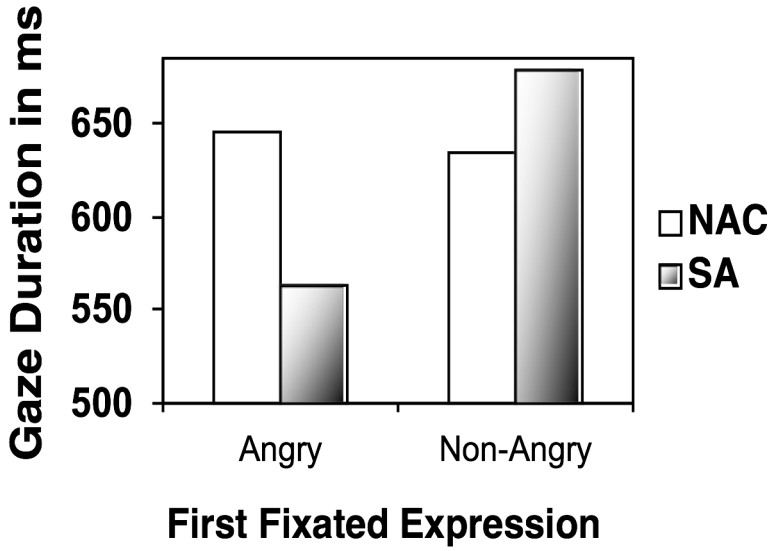


**Figure 5.4** *Mean gaze duration in ms for angry and non-angry expressions per group.*

fixation fell on an angry face, rather than a non-angry one, SAs looked away from it more quickly than NACs, $F(1, 41) = 5.15$, MSE = 171980, $p < .05$ (Figure 5.4). This was true of both neutral-angry crowds, $t(41) = 2.66$, $p < .05$, and smiling-angry crowds, $t(41) = 2.71$, $p = .01$.

## Discussion

In the present study, we investigated explicit evaluation of facial crowds by socially anxious participants (SAs) and non-anxious controls (NACs). We were particularly interested in how eye movement patterns predicted friendliness ratings, and whether the patterns differed between SAs and NACs.

*Crowd rating*

The results of the Crowd Rating Task revealed that SAs did not rate emotional crowds differently than NACs. In general, friendliness ratings decreased linearly with increasing number of angry faces in the facial matrix, independent of crowd type or presentation time.[3]

The lack of group difference in the direct rating task could be explained by a number of mechanisms. While exploring the facial displays, all participants could have logically inferred that friendliness ratings should decline as the number of angry faces in the crowds increased. Late elaborate processing may also have offered an opportunity for both groups to re-appraise initial, impulsive evaluations. Initial positive evaluations could, for instance, arise from a 'positivity-bias', often observed in a non-clinical population (Joormann & Gotlib, 2007; Murphy, Hirsch, Mathews, Smith, & Clark, 2007). The fact that quick evaluations were more positive than elaborate ones provides evidence of such a mechanism, although there is no evidence that this bias does not exist in SAs (e.g., Hirsch & Mathews, 2000). If a late re-evaluation indeed takes place, it appears to be a rather general process, not influenced by or sensitive to degree of social anxiety.

Social desirability effects might provide another explanation for the lack of divergence in the “friendliness” ratings. Socially anxious participants in experiments are believed to be particularly sensitive to social desirability (compare: Gilbert, 2001; Osman, Gutierrez, Barrios, Kopper, & Chiros, 1998; Schnabel, Banse, & Asendorpf, 2006). Accordingly, SA might have re-appraised the crowds in a way that they believed was expected from them as “reliable” research participants. Another possibly is that, “threat” and “friendliness” are not as clearly linked as we thought. Asking participants directly how threatening they found the crowds would probably have been more straightforward and less susceptible to social desirability effects. Another confound is that the terms “friendliness” or “threat” are not entirely obvious when linked to pictures of groups. Asking how intimidating one finds the group when imagining that one has to present a talk in front of this crowd might have been more ecologically valid, and may have elicited a dissociation between SAs and NACs.

Finally, there is also good reason to assume that there are indeed no explicit rating differences between the groups. If quick, initial threat evaluations do not interfere with controlled cognitive processes, but instead direct eye movement patterns resulting in subsequent behavior tendencies, no rating differences would have been observed with our explicit measure. Indeed, Heuer et al. (2007), but also Lange et al. (2008) found that socially anxious individuals show automatic avoidance tendencies to emotional faces in an indirect task, while showing no differences on direct evaluation of the material, when compared to non-anxious controls.

From the above it becomes evident that the friendliness ratings by themselves do not contribute to a clear understanding of how social anxiety is related to the direct evaluation of facial crowds. In the following section, we explore whether eye

movement patterns are more conclusive and how they correlate with the ratings of the crowds.

*Eye movement*

From the eye movement data of the present study it became clear that the number of angry faces in the center *and* the proportion of actually fixated angry pictures, rather than the absolute ratio of angry to other faces best predicted rating outcomes. This sounds logical as attention was redirected to the fixation cross in the middle of the screen at the beginning of each trial. Thus, a high number of angry faces in the central positions was likely to indicate a higher number of angry faces in the rest of the crowd, $r(42) = .311$, $p = .05$. Consequently, ratings became more negative when angry faces were fixated in central positions. Second, ratings are presumably based on what one really saw during each trial. Therefore correlations of ratings with ratio are low and insignificant with the short presentation time ($r_{500ms}(42) = .174$, p = ns) and become more relevant with the long presentation time ($r_{2500ms}(42) = .371$, $p = .05$). This means, only if one pays attention to (here: fixates) the angry pictures, can one come to a justified conclusion.

*Pop-out.* Interestingly, participants' proportion of fixated angry faces did not parallel the factual proportion of angry faces in a crowd. In fact, all participants tended to make more fixations on angry faces when they constituted less than 50% of the crowd and fixated more on non-angry faces when those formed the minority. It could be argued that this effect is produced by a more general "pop-out" effect (Treisman, 1982; Treisman & Gelade, 1980), promoting novelty in the visual field (compare: Lange, Heuer, Reinecke, Becker, & Rinck, 2008; Lupianez, Klein, &

Bartolomeo, 2006; Theeuwes & Van der Stigchel, 2006). Here, a pop-out effect, be it for incongruent faces, or for angry faces only, is rather unlikely, though. While the “anger-superiority-effect” (Hansen & Hansen, 1988) has often been replicated with different variations of this “face-in-the-crowd” visual search paradigm (Eastwood et al., 2005; Gilboa-Schechtman et al., 1999; Öhman et al., 2001), there is dissent regarding the underlying attentional mechanisms. A major point is that in the present study, the crowds did not require searching, but simply had to be viewed prior to rating. Additionally, the facial matrices consisted of 16 different individuals showing varying ratios of two expressions, making serial exploration of every face more probable; having 16 identical faces with one incongruent expression, or 15+1 prototypic schematic faces, make pop-out more likely. If pop-out does occur in our task, it would make sense to assume that first fixations are more likely on angry faces, but in our research they were not. This finding is in agreement with research from Calvo, Avero, and Lundqvist (2006), who, using a classical face-in-the-crowd set-up with four schematic faces while registering eye movements, did not find a higher proportion of angry faces among first fixations. Hampton and colleagues (1989), but also Horstmann (2007) have already argued that observed position effects in a search array as well as insufficiency of the search slopes renders pop-out effects rather unlikely.

Additionally, Bichot and Desimone (2006) suggests that pop-out (parallel processing) and serial processing are difficult to discern as they neurologically seem to switch back and forth during visual search, depending on stimulus complexity. According to Hahn and Grolund (2007; but see also: Williams et al., 2005), preferential processing of threat is most obvious when no specific instructions are

given (i.e. “indicate if an incongruent face is present or not”), but can be mediated by a specific “top-down” instruction to, e.g., find a happy face (compare: Rinck, Reinecke, Ellwart, Heuer, & Becker, 2005). In the presented study, we gave participants specific instructions to rate the friendliness of each crowd from -3 to +3. It is possible that the specificity of this task and the associated strategies may circumvent disorder-relevant mediation of friendliness ratings by angry faces in SA.

We have to be aware that our experimental set-up does not allow conclusions about pre-attentive processing nor covert attention (Posner, 1980). It is possible that anger is identified in a pre-attentive state triggering facilitated processing before overt attention “takes over”. This could explain how participants in Calvo and colleagues’ experiments showed enhanced accuracy in identifying discrepant angry faces in neutral crowds when presented parafoveally for 150 ms (Calvo et al., 2006). In fact, angry faces were detected more accurately despite being looked at for a shorter period than other expressions.

*Attentional avoidance.* Calvo et al. (2006) suggested that pre-attentive processing makes longer focus times on angry faces unnecessary, because they are fully processed in a shorter time, while similar observations have occasionally been interpreted as attentional avoidance (e.g., Chen, Ehlers, Clark, & Mansell, 2002; Horley, Williams, Gonsalvez, & Gordon, 2004; Koster, Crombez, Verschuere, Damme, & Wiersema, 2006; Mansell, Clark, Ehlers, & Chen, 1999). Our data conveys a similar idea: Social anxiety was associated with a tendency to quickly avert the gaze only from angry initially-fixated faces. This could also explain the higher proportion of angry faces fixated and the slightly longer gaze durations on non-angry faces. Horstmann (2007) acknowledges a preferential processing of threat

related cues, but on the other hand, he doubts that the processing is pre-attentive. In our study, we unfortunately do not have any other means of investigating whether any pre-attentive processing has taken place, and if quick aversion of gaze is a sign of completed processing, rather than avoidance. Conclusively, and in contrast to literature (e.g., Fox, 2004; Georgiou et al., 2005; Horley et al., 2004; Mogg, Philippot, & Bradley, 2004) suggesting attentional vigilance to threat, first vigilance and then avoidance, or disrupted disengagement from threat, our findings imply a general novelty-bias for the smaller number of incongruent faces in a crowd, with a no-vigilance-but-quick-avoidance pattern seen in socially anxious participants, at least when overt attention is concerned.

Surprisingly, we cannot conclude that the higher proportion of angry faces fixated by SAs, led to observable, more negative ratings. The shorter gaze duration of SAs on first fixated angry pictures was not sufficient to produce rating differences between SAs and NACs, either.

*Conclusion*

These findings have a number of implications. In general, we assume that SAs, due to their learning history and/or genetic makeup, should be more sensitive to socio-evaluative threat than NACs (Fox, Hane, & Pine, 2007). This hypersensitivity may lead to SAs being incapable of ignoring social threat (negative facial expressions) in their environment. However, some studies indicate that angry (threatening, negative) faces seem to be preferentially processed in individuals with elevated levels of social or trait anxiety, but not in NACs (Fox, 2004; Gilboa-Schechtman et al., 1999; Kolassa & Miltner, 2006; Lange et al., 2008; Mogg et al., 2004; Stein, Goldin, Sareen, Zorrilla,

& Brown, 2002), while other researchers suggest a more general anger-superiority-effect unrelated to anxiety-proneness (Calvo et al., 2006; de Jong & Martens, 2007; Horstmann & Bauland, 2006; Öhman et al., 2001; Springer, Rosas, McGetrick, & Bowers, 2007; Williams et al., 2005). Another problem arises from the increasing evidence that unconscious and conscious processing of danger-related cues might travel via different neuronal pathways (Herba et al., 2007; Ohrmann et al., 2007; Palermo & Rhodes, 2007; Vuilleumier, 2002). For example, Etkin, Klemenhagen, Dudman, et al. (2004) found that conscious presentation of fearful faces consistently activated the dorsal amgydala in all participants. With unconscious presentation, however, activation of the basolateral subregion of the amgydala was correlated with participants' reported trait anxiety and predicted reaction times on a face-color judgment task. Concurrently, Williams, Liddell, Kemp, et al. (2006) found right amygdala, and ventral anterior cingulate responses to subliminal presentation of fearful faces and left-sided amygdala, dorsal anterior cingulate and medial prefrontal activation followed supraliminal stimulus presentation. Öhman (2005) observed that the amygdala is generally activated with subliminal presentation of fear-relevant stimuli such as angry faces, spiders and snakes. When processed consciously, initial amygdala and cortical network activation to fear-relevant stimuli that are not individually relevant (e.g. spider pictures to a snake phobic) are inhibited. Only when the individual fears the particular stimulus do the relevant neural regions become active.

Taken together, this could mean that a threat evaluation could take place at different, perhaps independent cognitive levels. Evolutionary predisposition or repeated threat-related learning experiences could lead to automatization of

subconscious (elevated) threat evaluation and processing which could initiate biased automatic behavior patterns such as eye movement (e.g., Calvo et al., 2006), shifting of covert attention (e.g., Fox, Russo, Bowles, & Dutton, 2001; Fox, Russo, & Dutton, 2002), or avoidance tendencies (Heuer et al., 2007). If an individual is not consciously aware of his or her threat-appraisal of e.g., angry faces, subjective ratings of faces might not tap into those processes, while indirect measures would. On the other hand, both levels might not necessarily require a *threat* appraisal. Simple negative evaluation may be sufficient to lower the threshold for preferential processing (compare cognitive-motivational model of: Mogg & Bradley, 1998, 2004). This could partially explain the diverging evidence for preferential processing of angry faces, sometimes found in trait or socially anxious but not in non-anxious populations, sometimes found in non-anxious participants only and sometimes in both, but more pronounced in the more anxious populations.

In future research, the basis of such diverging evidence has to be explored in greater detail. It is essential to clarify why SAs looked faster away from first fixated angry faces, and why their proportion of fixated angry faxes was higher than for other expressions without having any differentiating impact on subjective ratings of the very same group of faces. Results in this domain would help to revise present models of cognitive processes in social phobia, to gain understanding of the role of angry faces herein and to differentiate (the influence of) divergent cognitive evaluation processes and their influences on an individual’s behavior.

Footnotes

[1] Since Lange, Keijsers, Rinck, & Becker (2008) discovered speeded processing of especially *male* angry faces in a flanker paradigm, we attempted to enhance the possible influence negative/angry faces have on the evaluation of a crowd by using only male crowds.

[2] Whenever appropriate, the same analyses were applied to the central four pictures only. That would result in a 2 (crowd type: neutral-angry, happy-angry) × 5 (expression ratio: 4:0, 3:1, 2:2, 1:3, 0:4) × 2 (presentation time: 500, 2500) × 2 (social anxiety: low, high) design.

[3] In three other experiments (two unpublished), we tested different facets of the direct evaluation of crowds. Manipulations of crowd size, instruction or response window revealed no differences in ratings between socially anxious and non-anxious participants (compare: Lange et al., 2008).

Chapter 6

# Social Anxiety and the Evaluation of Social Crowds: Explicit and Implicit Measures

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## Abstract

To investigate whether Social Anxiety Disorder is indeed characterized by a biased negative evaluation of facial expressions, 25 highly socially anxious (SAs) participants and 30 non-anxious controls (NACs) were asked to respond to different ratios of neutral-angry or happy-angry face combinations (crowds). In an indirect Approach-Avoidance Task (AAT), participants used a joystick to pull the crowds towards themselves (approach) or push them away (avoidance). SAs showed faster avoidance of neutral-angry crowds when the number of angry faces in the crowd increased. The happy-angry crowds were generally avoided, independent of the ratio of the two emotions. NACs did not show any specific response tendency. When directly rating the friendliness of the crowds, the two groups did not differ.

## Introduction

In recent years, it has repeatedly been suggested (e.g., Beck & Clark, 1997; Clark & Wells, 1995; Rapee & Heimberg, 1997) that biases in information processing (e.g., attentional biases, interpretation biases) of patients meeting the criteria for social anxiety disorder (or social phobia; American Psychiatric Association, 2000; APA) contribute to the maintenance of the disorder (Foa et al., 1996; Heinrichs & Hofmann, 2001; Hirsch & Clark, 2004; Stopa & Clark, 1993). As negative evaluation by others is the greatest fear of socially anxious patients, negative biases in interpretations and judgments of social situations are considered the most prominent candidates for dysfunctional cognitive processes in social anxiety disorder (Foa et al., 2001; Mathews & Mackintosh, 2000). So far, research of interpretation biases in socially anxiety has been predominantly focused on text vignettes describing social scenarios. When participants rate, interpret or judge the likelihood of outcomes of written *ambiguous* social situations, findings have frequently shown that social anxiety appears to be associated with a negative interpretation style (Amir et al., 1998b; Brendle & Wenzel, 2004; Hirsch & Clark, 2004; Huppert et al., 2003; Stopa & Clark, 2000; Voncken et al., 2003).

Contrary to the fairly straightforward findings with text materials, there is less persuasive evidence when participants have to process facial expressions. While some studies suggest attentional vigilance for (emotional) faces in general or only for angry faces, others suggest avoidant attention patterns for threat cues (for critical reviews see: Hermans & van Honk, 2006; Ledley & Heimberg, 2006). There has

been some evidence that participants high in (social) anxiety show a recognition bias for negative facial expressions (Abrams, 1999; Surcinelli et al., 2006), but the evidence for a biased evaluation of faces is equivocal. Merckelbach, Van Hout, Van den Hout, and Mersch (1989), for example, found that socially phobic participants did not process angry faces any differently than non-anxious controls did. In both groups, angry faces elicited higher skin conductance responses, inhibited eyeblink rates and yielded more negative explicit evaluations than either happy faces or neutral objects did. Philippot and Douilliez (2003; Philippot & Douilliez, 2005; Winton et al., 1995) asked socially phobic participants, anxious controls and non-anxious controls to rate different intensities (0%, 30%, 70%, 100%) of happy, angry, sad, disgusted, and fearful faces morphed with neutral ones. They asked how strongly the portrayed emotion would resemble shame, disgust, surprise, anger, happiness, sadness, or fear. Results lent no support for the notion that socially phobic participants or participants diagnosed with other anxiety disorders showed signs of deficits or superiority in emotion decoding. With a slightly different approach, Winton, Clark, and Edelmann (1995) did not find a deficit/superiority effect in socially anxious participants, either, when they had to identify the emotions of presented face stimuli (Experiment 1). However, they found a general tendency to judge emotions of others seen in brief video fragments as being negative (Experiment 2; Winton et al., 1995). In a study by Gilboa-Schechtman, Presburger, Marom and Hermesh (2005), socially anxious patients with and without comorbid depression and control participants rated how threatening were crowds with mixed emotional facial expressions. Anxious participants evaluated the predominantly disapproving crowds more negatively than controls. The inconsistency in these results is rather puzzling, assuming that

emotional facial expressions are inherently ambiguous (also in groups; Gilboa-Schechtman et al., 2005) and of high evolutionary value (Haxby et al., 2000; Juth et al., 2005; Öhman, 2002; Öhman, Flykt et al., 2001; Öhman & Mineka, 2001), especially for communication in social interaction.

Assuming that neurological hardwiring facilitates face processing (Haxby et al., 2000; Herrmann et al., 2005; Vuilleumier, 2002, 2005), it is likely that the explicit ratings of facial expressions do not tap into automatic processes, and are not susceptible to possible processing biases. That is, automatic evaluation might have already taken place, and might have initiated congruent responses or behavior, while one is not consciously aware of or influenced by either the automatic evaluation or the response. Similarly, some dual processing models of social cognition (compare: Chaiken & Trope, 1999) assume that there is a dissociation between automatic, affective processes and intentional, cognitive processes. This could in fact explain the equivocal results in the field. In sum, it would be useful to assess automatic evaluations or responses indirectly without solely relying on subjective conscious reports. In this way, eventual dissociations between explicit and implicit evaluations of the same materials may be discovered and used to explain part of the inconsistencies. With the introduction of the Approach-Avoidance Task (AAT; Heuer et al., 2007; Rinck & Becker, 2007) it is possible to supplement explicit ratings by indirectly investigating attitudes or evaluations via associated behavior. The underlying idea of this task is that human beings have a tendency to automatically approach pleasant stimuli while avoiding unpleasant or threatening ones (e.g., Chen & Bargh, 1999; Solarz, 1960). Thus, inevitable automatic evaluation of a stimulus is thought to influence subsequent behavior, even when stimulus valence is not task

relevant. In the present version of the AAT, participants have to sort face displays according to their color shading by pushing or pulling a joystick. Here, reaction times (RTs) of either movement are indicative of the valence the participant implicitly attributes to the presented stimulus: Speeded pushing, or slowed pulling is interpreted as “avoidance” of a stimulus, while speeded pulling and slowed pushing reflects “approach.”

In the present study, we combined the different aforementioned notions. As stated above, it is supposed that emotional facial expressions are highly informative in a social context. It is hypothesized that crowds of faces are particularly threatening to people with elevated social anxiety even though related research is scarce. Our goal is to explore whether an indirect, behavioral measure sheds more light on threat evaluation of faces than explicit evaluations do. In a first task (AAT), we investigated how pictures of groups (“crowds”) showing task-irrelevant emotional expressions influence Socially Anxious participants’ (SAs) and Non-Anxious Control participants’ (NACs) reaction times (RTs) when sorting the pictures according to their color by pushing or pulling a joystick. Participants’ approach-avoidance reactions were recorded, and it is assumed that the number of angry faces shown in a crowd will influence the speed of the responses in the two groups differently. In a second task (Rating Task), we asked participants to explicitly evaluate the friendliness of the same emotional crowds used in the indirect task.

## Approach-Avoidance Task

In this task, we investigated the influence of social anxiety on automatic approach/avoidance responses when “crowds” composed of different emotional expressions where presented. The sorting of the stimuli according to the color of the pictures was done by “pushing” one color or “pulling” the other color with a joystick. Reaction times for the movements were interpreted as indices for automatic approach (pull) and avoidance (push) tendencies from which an effect score (AAT effect) is calculated by subtracting the RTs for a pull-movement from those of push-movements.

First, it was assumed that the RT patterns of both groups would indicate that the crowds consisting of neutral and angry faces were perceived as more threatening than crowds consisting of happy and angry faces. This would be reflected in more negative AAT effects for the former and more positive effects for the latter combination. Second, we expected an overall more negative AAT effect for the SA participants. That is, SAs were predicted to be generally more avoidant with respect to social crowds and thus faster than NACs in pushing them away than in pulling them closer. Third, we predicted for both groups that AAT effects would become increasingly negative (i.e., faster pushing than pulling) with an increasing number of angry faces in the crowd. Finally, and most importantly, we expected greater sensitivity to threatening stimuli in SA participants. That is, the differences in AAT effects between the two anxiety groups were predicted to increase with an increasing number of angry faces in the matrices. An increasingly negative response

in NACs to increasing numbers of angry faces, if present at all, is expected to be far less pronounced than that of SAs.

## Methods

*Prescreening, Participants, and Measures*

During class, undergraduate psychology students of Radboud University Nijmegen filled in the Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987; Oakman et al., 2003). They were selected according to their LSAS scores (≤ 13 or ≥ 27 on the anxiety subscale) and invited for two days of testing, with the two sessions separated by 7 days[1]. This procedure resulted in 25 Socially Anxious participants (SAs) and 30 Non-Anxious Controls (NACs), all female, completing both testing sessions. Each session lasted for 20 minutes. Participants received a payment of €3 per session or course credit.

When entering the laboratory on Day 1, participants completed the LSAS for a second time. Those scoring above 13 and below 27 on the anxiety subscale were excluded from further participation. Before the computer tasks of each of the two sessions, participants also completed the Fear of Negative Evaluation Scale (FNE; Duke et al., 2006; Leary, 1983), a general screening instrument for eyesight, handedness, education, and use of medication, and the state version of the State/Trait Anxiety Inventory (here: STAI-State1; Spielberger et al., 1983). After the computer tasks, participants filled in the STAI again (here: STAI-State2), the Symptom Check List-90 (SCL-90; Derogatis, 1994), a self-report instrument for psychopathological symptoms, the Beck Depression Inventory (BDI; Beck et al., 1961), and the trait-version of the STAI (STAI-Trait).

*Apparatus*

The task was conducted on a computer with a 451 MHz Intel Pentium III processor and 256MB of RAM running Windows XP Professional. The connected monitor-type was “Vision Master Pro 410” from Iiama Electric Cooperation. The employed joystick was a “Logitech Attack 3.” A DOS-based executable file presented the stimuli and measured response times in milliseconds.

*Materials*

A selection of color photos of 12 individuals (all male), each presenting one of three different facial expressions (angry, neutral and happy), was taken from the Karolinska Directed Emotional Faces database (KDEF; Lundqvist et al., 1998). The photos were resized to 72.0 mm by 98.8 mm, 32-bit color. Using these 36 photos, matrices of 12 (4 x 3) facial expressions were constructed to vary in the degree of social approval/disapproval. Two types of crowds were created: neutral-angry combinations and happy-angry combinations. The degree of threat was varied by gradually manipulating the ratio of angry to other expression pictures in the crowd. Seven different ratios were composed: 12:0 (e.g., 12 neutral and zero angry pictures), 11:1, 9:3, 6:6, 3:9, 1:11, and 0:12 (see Figure 6.1). Each individual and each emotional expression were randomly assigned to a position. Every crowd type x ratio combination was made in two different color shadings, reddish versus brownish, and in seven different sizes ranging from 200 x 202 pixels to 760 x 768 pixels.

*Procedure*

Participants were seated approximately 50 cm from the computer monitor and 25 cm from a standard computer joystick, with the joystick located between them and the monitor. Then the computer program was started. They were told that all further instructions would be shown on the screen and that there was plenty of opportunity to practice. If they had questions, participants were asked to pose them before or immediately after the practice-trials. The participants' task was to indicate the color shading of each multi-facial matrix ("crowd") that appeared on the screen by pushing or pulling the joystick as quickly as possible until the matrix disappeared. Every other participant was instructed to push in response to brown matrices and pull in response to red matrices, while for the rest of the participants they were given the reverse instructions (i.e., push for red, pull for brown). Each trial had to be initiated by pushing the "fire"-button of the joystick. A matrix initially appeared in medium size (500 x 505 pixels). When the joystick was pulled, the matrix increased in size to give the impression of pulling the crowd closer. Pulling all the way made the matrix disappear. When pushing the joystick, the size of the crowd decreased in size to give the impression that the crowd was pushed away. Here, the display disappeared when the joystick was pushed all the way.

Participants first completed 24 practice trials with all-neutral crowds to get acquainted with the use of the joystick. In the main experiment, participants completed two blocks of 168 trials each. The 336 trials were divided equally into 12 trials per condition (2 crowd types x 7 ratios x 2 motions). The instructions concerning pulling and pushing the joystick in relation to the shading of the display (brown = push and red = pull vs. brown = pull and red = push) were counterbalanced

across participants.

The sequence of a trial was as follows. First a black screen appeared until the "fire"-button was pushed. Then a matrix with either a reddish or a brownish shading appeared in its initial (medium) size. Whenever the joystick was pushed or pulled the

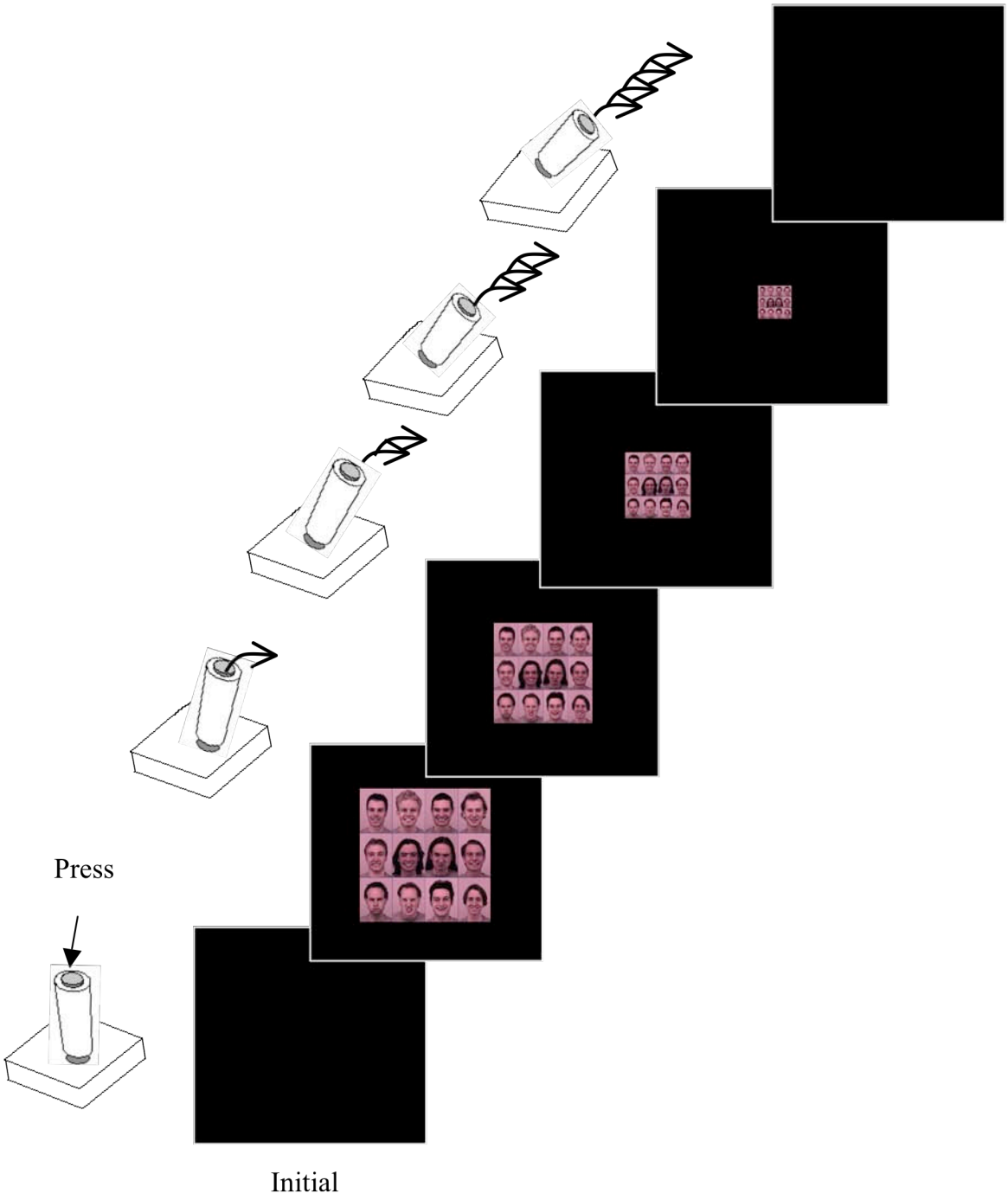


**Figure 6.1** *Example of a sequence of the AAT.*

picture size changed accordingly. The picture disappeared only when the joystick reached one of the two end positions (see Figure 6.1). RT measurement started upon presentation of the picture, was recorded at all intermediate positions, and stopped at the end position when the matrix disappeared. Once the matrix disappeared, the participant started the next trial by moving the joystick back to the central position and pushing the button.

When the computer task ended, participants were asked to complete the remainder of the questionnaires. Then they were debriefed, paid, and thanked for their participation.

*Design*

A 2 (crowd type: neutral-angry, happy-angry) x 7 (expression ratio: 12:0, 11:1, 9:3, 6:6, 3:9, 1:11, 0:12) x 2 (movement: pull, push) x 2 (group: socially anxious, non-anxious) factorial design was used to analyze the RTs. Since previous AAT experiments have shown that the data for the intermediate joystick positions have comparable effects, only the RTs of the end positions were analyzed. While degree of anxiety was a between-subjects factor, crowd type, ratio, and movement instructions were within-subjects factors. Whenever the basic assumption of univariate testing (i.e., sphericity) was violated in any of the analyses, appropriate, more conservative tests with corrections of degrees of freedom were used (i.e., Huynh-Feldt). Additionally, because of the high number of levels of the “ratio” factor, we analyzed the contrasts/gradients of the resulting regression lines, correcting for the uneven spacing between ratios.

AAT effects were used as the dependent variable. They were calculated by subtracting each participant's median RT for pulling a certain kind of crowd from his/her RT for pushing them. Reaction time patterns were compared between groups. That is, the responses to different ratios and crowd types of SA participants were compared to the responses to the same ratios and crowd types of NACs. An alpha level of .05 was used for all statistical tests.

## Results

*Population characteristics.* SAs ($M$ = 19.12, $SD$ = 1.30) and NACs ($M$ = 19.40, $SD$ = 1.35) did not significantly differ in age, $t(53) = 0.78$; $p = .44$, or education, $\chi^2$ (2, $N$ = 55) = 0.4, $p = .82$. SAs scored significantly higher on several scales of anxiety

**Table 6.1** *Means (M) and standard deviations (SD) of questionnaire scores for socially anxious (SAs) and non-anxious controls (NACs) for all participants: Liebowitz Social Anxiety Scale (LSAS), Fear of Negative Evaluation (FNE), the trait version of the Spielberger State/Trait Anxiety Inventory (STAI-Trait), State versions of the STAI before (State1) and after (State2) the computer task, Beck's Depression Inventory (BDI), and the Symptom Check List (SCL90)*

| | Group | | | |
|---|---|---|---|---|
| | SA ($n$=32) | | NAC ($n$=34) | |
| Questionnaires | *M* | *SD* | *M* | *SD* |
| LSAS-anxiety** | 35.6 | 7.1 | 9.0 | 2.6 |
| FNE** | 33.6 | 8.5 | 14.7 | 7.3 |
| STAI-Trait** | 41.8 | 9.3 | 32.3 | 6.4 |
| STAI-State1** | 38.0 | 8.1 | 29.1 | 6.3 |
| STAI-State2* | 38.2 | 8.8 | 30.3 | 6.9 |
| BDI** | 9.3 | 5.6 | 5.5 | 4.1 |
| SCL90** | 148.4 | 29.6 | 120.2 | 24.4 |

*$p < .01$, two-tailed. **$p < .001$, two-tailed.

related concepts, as well as on questionnaires measuring co-morbidity common in social anxiety. Specifically, they scored higher on LSAS, FNE, STAI-state/trait, BDI, and the SCL90. The two groups differed in their level of state anxiety both before and after the tasks, $t(52)= 4.15$, $p < .01$, and $t(52) = 3.64$, $p < .01$ respectively. State anxiety itself, though, was not affected by the computer task, $F(1, 52) = 0.47$; MSE = 14.34; $p = .50$, nor did it interact with group, $F(1, 52) < 1$ (see Table 6.1).

*AAT effects in general.* In the overall analysis, there was no significant main effect of crowd type, $F(1, 53) < 1$, MSE = 3423.4, $p = .75$. However, the interaction of group and crowd type was significant, $F(1, 53) = 4.29$, MSE = 3423.4, $p < .05$. For NACs, the AAT effects were slightly negative ($M = -3$, $SD = 6$) for neutral-angry crowds and positive for happy-angry crowds ($M = 7$, $SD = 6$). In contrast, the AAT effects of SAs were strongly negative for both the neutral-angry crowds ($M = -20$, $SD = 7$) and the happy-angry crowds ($M = -27$, $SD = 7$). Additionally, there was a significant main effect of group, $F(1, 53) = 9.42$, MSE = 13125.38, $p < .01$ (for raw data see Table 6.2). The overall AAT effect was more negative for SAs ($M = -24$, $SD = 6$) than for NACs ($M = 2$, $SD = 6$).[2] This means that SAs were generally faster to push crowds away than to pull them closer. There was no main effect of number of angry faces, $F(6, 318) = 1.4$, MSE = 3454.3, $p = .21$, nor any interaction with anxiety, $F(6, 318) = 0.3$, MSE = 3454.3, $p = .94$. To test whether the results could be explained by any of the other anxiety-related concepts, the correlations between questionnaires and AAT effects were analyzed. AAT responses were not correlated to the degree of psychopathology in general (total score of SCL-90), depressive symptoms (BDI), or trait anxiety (STAI-T).

*AAT effects for neutral-angry crowds.* The interaction of group and crowd type made it necessary to investigate the two crowd types separately. When analyzing the neutral-angry crowds, the main effect of group was marginally significant, $F(1, 53) = 3.09$, MSE = 8594.3, $p = .09$. The interaction of number of angry faces and group was not significant, $F(6, 318) < 1$, MSE = 3290.86, $p = .64$. However, when looking at the overall response pattern reflected in the corrected gradients of each group's regression line for the neutral-angry combinations (Figure 6.2), it appears as if the number of angry faces in an otherwise neutral crowd played a different role for

**Table 6.2** *Means (M) and standard deviations (SD) of RTs for socially anxious participants (SAs) and non-anxious controls (NACs) per movement for all seven ratios in Neutral-Angry crowds and Happy-Angry crowds*

| | SA (*n*=25) | | | | | | | NAC (*n*=30) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Neutral-Angry | | | | | | | | | | | | | |
| Ratio | 12:0 | 11:1 | 9:3 | 6:6 | 3:9 | 1:11 | 0:12 | 12:0 | 11:1 | 9:3 | 6:6 | 3:9 | 1:11 | 0:12 |
| $M_{Pull}$ | 670 | 679 | 683 | 702 | 684 | 694 | 700 | 617 | 647 | 634 | 640 | 638 | 638 | 630 |
| $SD_{Pull}$ | 102 | 114 | 82 | 96 | 107 | 93 | 97 | 65 | 62 | 86 | 86 | 74 | 79 | 58 |
| $M_{Push}$ | 669 | 666 | 668 | 676 | 656 | 661 | 658 | 620 | 647 | 632 | 631 | 632 | 634 | 625 |
| $SD_{Push}$ | 114 | 102 | 101 | 117 | 107 | 100 | 98 | 57 | 65 | 70 | 71 | 70 | 59 | 62 |
| | Happy-Angry | | | | | | | | | | | | | |
| Ratio | 12:0 | 11:1 | 9:3 | 6:6 | 3:9 | 1:11 | 0:12 | 12:0 | 11:1 | 9:3 | 6:6 | 3:9 | 1:11 | 0:12 |
| $M_{Pull}$ | 682 | 694 | 685 | 692 | 694 | 707 | 680 | 612 | 620 | 614 | 613 | 633 | 644 | 637 |
| $SD_{Pull}$ | 107 | 104 | 95 | 106 | 122 | 113 | 113 | 74 | 76 | 74 | 67 | 80 | 80 | 61 |
| $M_{Push}$ | 651 | 676 | 655 | 666 | 674 | 676 | 644 | 627 | 634 | 625 | 623 | 632 | 646 | 636 |
| $SD_{Push}$ | 94 | 126 | 101 | 108 | 98 | 107 | 79 | 71 | 68 | 61 | 70 | 71 | 69 | 68 |

SAs than it did for NACs. The interaction between number of angry faces and group was marginally significant, $F(1, 53) = 4.03$, MSE = 2642.86, $p = .05$. Although, strictly speaking, the non-significant trend does not allow for additional analyses, further exploration was considered helpful for understanding the processes at hand. It appeared that, keeping the statistical restriction in mind, the slope of socially anxious participants differed significantly from zero, $F(1, 24) = 7.06$, MSE = 4211.8, $p < .05$, while it did not for the NACs, $F(1, 29) < 1$, MSE = 1516.7, $p = .36$. Thus, a greater proportion of angry faces seems to have evoked more avoidance in SAs, but not in NACs (Figure 6.2).

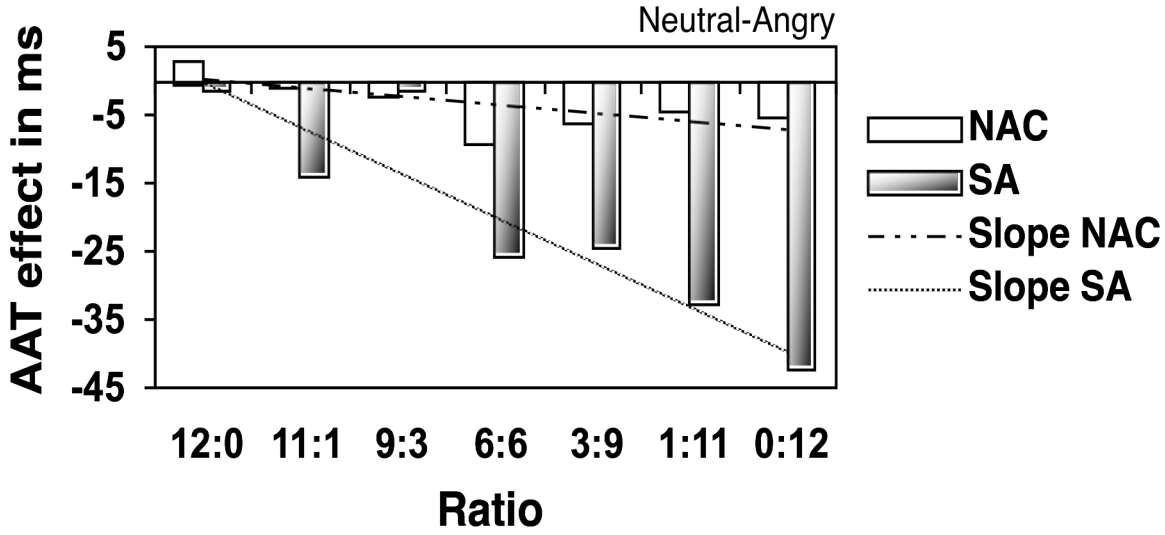


**Figure 6.2** *Mean AAT-effects in milliseconds for neutral-angry crowds per ratio per group.*

This conclusion was also supported by analyses of the all-same expression crowds. AAT effects did not differ between groups when only all-neutral crowds were compared, $t(53) = 0.24$, $p = .81$. Additionally, they did not differ significantly from zero, neither in SAs, $t(24) = 0.1$, $p = .92$, nor in NACs, $t(29) = 0.24$, $p = .81$. On the other hand, responses to all-angry crowds were significantly different between

groups, $t(53) = 2.17$, $p < .05$. Additionally, the responses to all-angry crowds differed significantly from zero for SAs, $t(24) = 2.70$, $p < .05$, but not for NACs, $t(29) = 0.55$, $p = .59$. In sum, these results suggest that only the SAs' AAT effects became more negative as the number of angry faces in a crowd increased.

*AAT effects for happy-angry crowds.* In contrast to the neutral-angry crowds, the main effect of group *was* significant for happy-angry crowds, $F(1, 53) = 14.05$, MSE = 7954.48, $p < .01$: Socially anxious participants showed more negative AAT effects than non-anxious control participants did (Figure 6.3). They were consistently

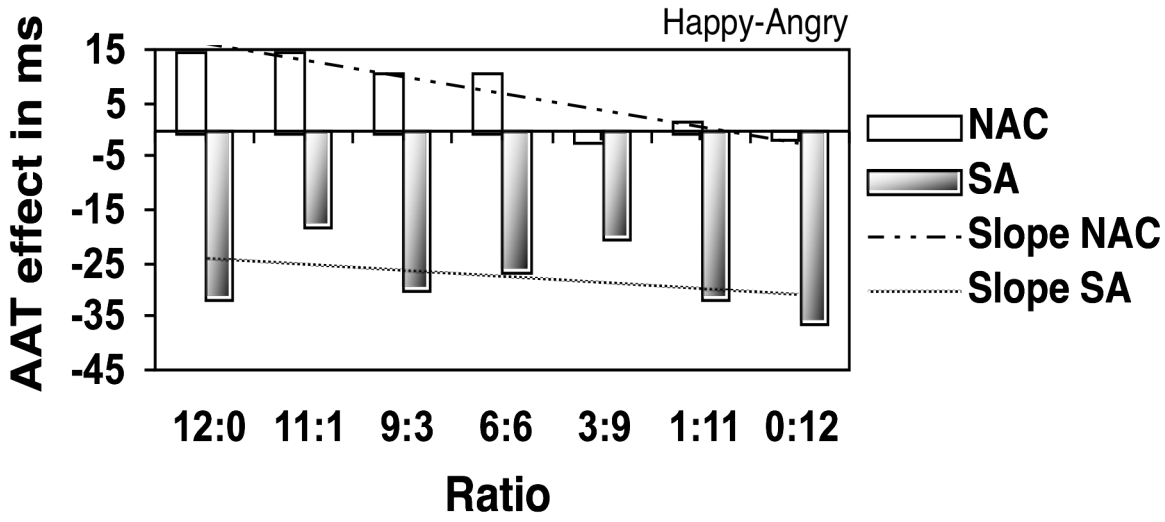


**Figure 6.3** *Mean AAT-effects in milliseconds for happy-angry crowds per ratio per group.*

faster in pushing than in pulling the crowds, independent of the ratio between happy and angry pictures. The interaction between number of angry faces and group was not significant, $F(6, 318) < 1$, MSE = 3400.57, $p = .83$. When investigating the slopes of the regression lines (corrected for the uneven spacing between the ratios), the interaction between number of angry faces and group was again not significant, $F(1,53) < 1$, MSE = 4276,63, $p = .57$. Additionally, neither the SAs' nor the NACs'

slopes differed significantly from zero, $F(1, 24) < 1$, MSE = 5531.0, $p = .70$ and $F(1, 29) = 2.5$, MSE = 3264.9, $p = .12$, respectively. This suggests that angry and happy faces trigger a similar avoidance reaction and that the ratio between the two emotions does not make a difference. In order to substantiate this claim we compared the AAT effects of all-happy crowds with all-angry ones per group. They were not significantly different in SAs, $t(24) = 0.23$, $p = .82$, nor in NACs, $t(29) = 0.99$, $p = .33$. Additionally, we tested whether the AAT effects differed from zero for SAs but not for NACs. SAs' reactions to all-angry crowds did differ from zero, $t(24) = 2.25$, $p < .05$, while responses to all-happy crowds were only marginally different from zero, $t(24) = 1.96$, $p = .06$. In NACs, neither of the two comparisons reached significance, $t(29) = 0.21$, $p = .83$ and $t(29) = 0.96$, $p = .34$, respectively. Thus, the number of angry faces in a happy crowd did not induce an additional, gradually increasing, negative automatic evaluation. In SAs, *both* emotional experessions seemed to elicit a comparable avoidance response not observed in NACs.

## Discussion

Keeping the statistical restrictions in mind, it is cautiously proposed that the different combinations of angry, happy, and neutral expressions seem to have an impact on automatic or implicit evaluations and on subsequent behavior. With an increasing number of angry faces in a neutral crowd, the SAs became seemingly faster in pushing the crowds away compared to pulling them closer. This gives rise to the notion that with an increasing number of angry faces, SA may tend to perceive or interpret the crowd as increasingly aversive or unpleasant. NACs did not show this

pattern. Their AAT effects for neutral-angry crowds did not significantly differ from zero. They did not have any apparent evaluative perception or interpretation affecting their behavior in one way or the other.

When combining happy and angry faces in a crowd, the picture looked somewhat different. Here, in general, SAs were quicker in pushing crowds away than in pulling them closer compared to NACs, independent of the number of angry faces in the crowd. This suggests that both emotional expressions provoked some kind of aversion-triggered avoidance response in SAs.

So far, we can conclude that pictures of angry facial expressions in group displays may have a tendency to provoke different behavioral response patterns in SA and in NAC participants, when the angry faces were in a crowd with either neutral or happy faces. From the observed patterns, it is hypothesized that both angry and happy faces in a group likewise initiate an immediate automatic negative evaluation indicated by a seemingly impulsive avoidance response in socially anxious participants. In order to investigate whether this implicit negative evaluation is also present after more elaborate processing, the following Crowd Rating Task explored explicit, subjective evaluations of the displays by SAs and NACs.

## Crowd Rating Task

In this Crowd Rating Task, we investigated whether the negative evaluative behavioral tendencies observed in SAs with the AAT could also be shown in a more direct way. For example, the first impulse of avoidance might lead to a negatively biased “post-hoc” interpretation of the friendliness of the crowd in question. With the initial avoidance response being more accessible, an immediate conscious

evaluation might be more biased than a more delayed reaction. In fact, later on, more strategic processes might take over and reappraisal might play a role, correcting and even erasing possible initial differences between the groups. Therefore, we asked the participants to subjectively rate the presented crowds in terms of friendliness, either immediately after seeing the display, or after a 2.5 second delay (compare: Gilboa-Schechtman et al., 2005).

Our first prediction was that in general, neutral-angry crowds should be rated more negatively than happy-angry crowds. Second, friendliness ratings for all participants should gradually decline with an increasing number of negative faces in the matrix. Third, in line with prior findings, we assumed that for the neutral-angry crowds, SAs would show a more pronounced decrease in ratings than NACs do. Fourth, we also assumed that SAs' subjective ratings of happy-angry crowds should generally be more negative than NACs' ratings of the same crowds, if SAs experience happy and angry faces as equally threatening. Finally, we expected that the findings should be more pronounced in the immediate ratings than in the delayed ones.

## Methods

*Participants*

As stated in footnote 1, this sample contained additional participants, for a total of 32 socially anxious participants and 34 non-anxious controls. Again, the experimental session lasted for 20 minutes, and participants received payment of €2 or course credit.

*Apparatus*

This task was conducted on an Apple eMac with integrated 17” monitor, operating at 700 MHz on Mac OS X 10.2.8.. Stimulus presentation and reaction time recording were controlled by the software RSVP 4.0.5 for Macintosh ( Williams & Tarr, 1998).

*Materials*

The crowd types and the ratios were constructed and randomized as in the former task, except that the crowds did not have a colored shading and were not constructed in varying sizes. They were 760 x 768 pixels in size and were presented in 32-bit color (see Figure 6.1).

*Procedure*

The pre-selection and the general procedure were the same as for the AAT session, except that no joystick was involved. Participants were given 36 practice trials to get acquainted with the use of the –3, –2, –1, +1, +2, +3 marked keys of the otherwise covered standard computer keyboard. They practiced pressing the six keys with the ring fingers, middle fingers and index fingers of their left and right hand. This way, participants learned to evaluate the crowds without taking their fingers off the six response keys and without looking away from the screen. In the main task, the participants had to subjectively judge how (un-)friendly they thought a presented crowd was after seeing it for 500 ms. The experiment consisted of two blocks. In one block, participants had to respond immediately after the crowd had disappeared (“response-window: immediate”). In a second block, participants had to delay their response for 2500 ms (“response-window: delayed”). The order of the blocks was

counterbalanced across participants. Before each block, there were 24 practice trials with different, gender-mixed crowds of each crowd type. In the main experiment, each block consisted of 2 sets of 84 trials each. The total of 336 trials was divided into 168 trials per crowd type. For each crowd type, each ratio was presented 12 times for each response window, with individuals and photo positions randomized (12 individuals, 12 positions).

The sequence of a trial was as follows. First a yellow fixation cross was displayed in the center of a blue screen for 1000 ms. The matrix of 12 faces ("crowd") was presented for 500 ms, after which the blue screen reappeared. Either immediately or after a delay of 2500 ms, depending on the response window condition, the word "now" (Dutch: "nu") reminded participants to react. The blank screen remained visible until the participant reacted or until 1000 ms had elapsed. If the latter was the case, the message "too late" (Dutch: "te laat") appeared and a buzzer sounded. After a subsequent 500 ms, the next trial began. Ratings as well as reaction times were recorded.

*Design*

A 2 (crowd type: neutral-angry, happy-angry) x 7 (expression ratio: 12:0, 11:1, 9:3, 6:6, 3:9, 1:11, 0:12) x 2 (response window: immediate, delayed) x 2 (group: socially anxious, non-anxious) factorial design was used for the analysis of the subjective ratings as well as the decision latencies. While group was a between-subjects factor, crowd type, ratio, and response window were within-subjects factors. As before, we analyzed the gradients of the regression lines, corrected for the uneven spacing

between the expression ratios. If not stated otherwise, statistical assumptions were identical to those stated in the AAT section.

## Results

*Population characteristics*. Including the additional participants, SAs ($M$ = 19.41, $SD$ = 1.5) and NACs ($M$ = 19.35, $SD$ = 1.48) did not significantly differ in age, $t(64)$ = 0.15, $p$ = .89, or education, $\chi^2$ (2, $N$ = 66) = 0.29, $p$ = .87. The previously reported

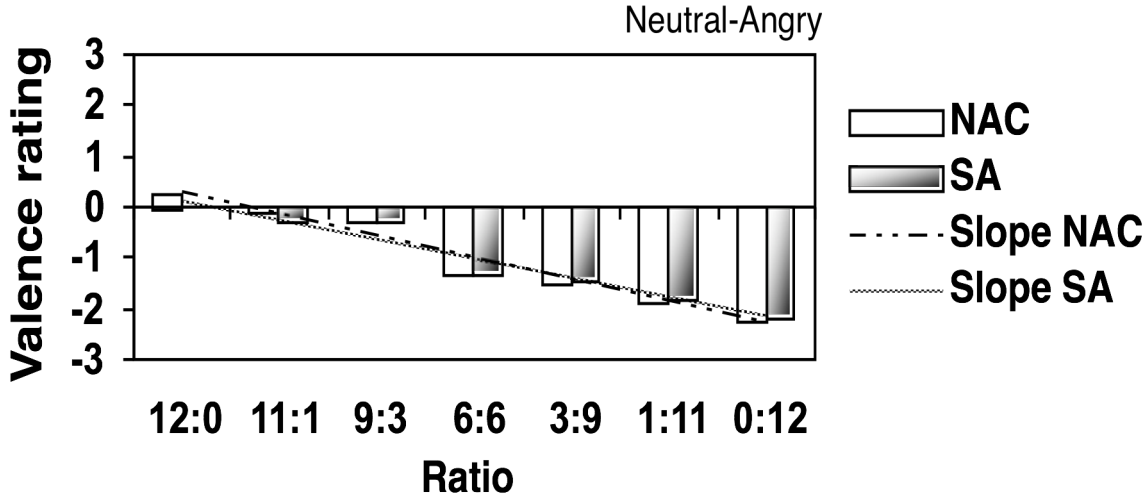


**Figure 6.4a** *Mean valence ratings for neutral-angry crowds per ratio per group.*

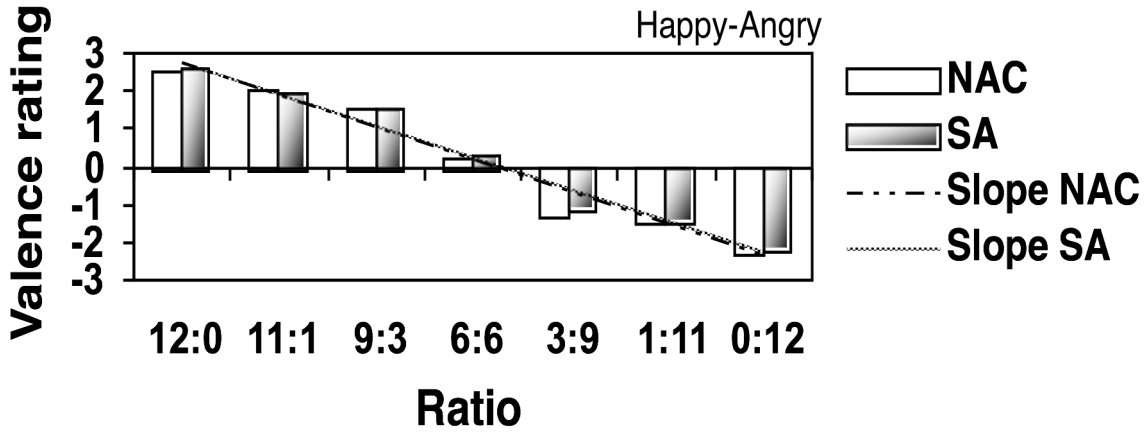


**Figure 6.4b** *Mean valence ratings for happy-angry crowds per ratio per group.*

significant effects on anxiety-related concepts and co-morbidity did not change with the additional participants (see Table 6.1).

*Ratings.* As expected, happy-angry crowds ($M$ = 0.22, $SD$ = 0.02) were rated more positively than neutral-angry crowds ($M$ = -0.99, $SD$ = 0.04), $F(1, 64) = 842.78$, MSE = 0.79, $p < .01$. There was a significant main effect for ratio as well, $F(2.2, 140.92) = 1481.55$, MSE = 0.91, $p < .01$: The ratings of both crowd types decreased with every angry face added to the matrix (Figures 6.4a & b). In contrast, neither the effect of group, $F(1, 64) < 1$, MSE = 1.31, $p = .83$, nor any of its relevant interactions reached statistical significance.[3] The analyses of the slopes (corrected for the uneven spacing between the ratios) did not reveal any additional information, besides that the slopes of both NACs and SA differed significantly from zero, $F(1, 33) = 1152.27$, MSE = 1.40, $p < .01$, and $F(1, 31) = 1162.22$, MSE = 1.16, $p < .01$, respectively. Finally, immediate reactions ($M$ = -0.41, $SD$ = 0.03) were generally more negative than delayed responses ($M$ = -0.37, $SD$ = 0.03), $F(1, 64) = 5.27$, MSE = 0.17, $p < .05$, but this effect of response window was not moderated by any other relevant factor. In sum, the friendliness ratings of both groups declined similarly with every additional threatening face in the crowd. Since no interaction between group and crowd type occurred, further analyses of the separate crowd types were omitted.

*Discussion*

The results of the Crowd Rating Task demonstrate that during explicit evaluations, socially anxious participants did not rate emotional crowds differently from non-anxious control participants. The number of angry faces in the crowds influenced both groups similarly; that is, the friendliness ratings decreased linearly with an

increasing number of angry faces in the crowds.[4] Further, the ratings made immediately after the presentation of the crowds were more negative than the ratings after a delay of 2.5 seconds. This, again, was independent of participant group.

## General Discussion

In the present study, we investigated implicit evaluations of emotional crowds, as reflected in approach-avoidance tendencies, and contrasted them with explicit valence ratings of the same material. We were particularly interested in finding out if negative behavioral responses towards facial crowds would differ between socially anxious participants (SAs) and non-anxious control participants (NACs), and in exploring to what degree implicit and explicit evaluations would diverge.

With an indirect Approach-Avoidance Task (AAT), we found a marginal increase in automatic avoidance responses for SAs when they were presented with an increasing number of angry faces in neutral-angry crowds. However, the effect did not reach standard levels of significance to unequivocally support this claim. Happy-angry crowds, on the other hand, clearly evoked a *general* avoidance response in SAs, independent of the different emotion-combining ratios. Thus, SAs seemed to be increasingly avoidant of neutral-angry crowds and generally avoidant of happy-angry crowds. In both cases, NACs did not show any behavioral preferences and instead were equally fast to approach as to avoid the different crowd types. In the direct Crowd Rating Task, participants were asked to explicitly rate the crowds that were used in the AAT. Surprisingly, here we found no differences between SAs and NACs at all, and no evidence for a negative evaluation

of happy faces by SAs, either. In fact, implicit evaluations were dissociated from the explicit ratings, for each crowd type: For neutral-angry crowds the correlation between ratings and AAT effects was low and not significant, $r(54) = .14$; $p = .31$. For happy-angry crowds the two tasks were not correlated either, $r(54) = .18$, $p = .18$.

The following discussion of theoretical implications must clearly be seen in the light of the statistical restrictions. The presence of angry faces in a neutral crowd appears to trigger an increase in threat evaluation in SAs. It seems plausible to assume that socially anxious people, due to their learning history and/or genetic setup, are much more sensitive to socio-evaluative threat than non-anxious people (Fox et al., 2007). The general tendency of SAs to push away social crowds more quickly than pulling them closer seems to support that view. Consequently, this hypersensitivity might render them incapable of ignoring social threat in their environment. Despite following the instructions of the AAT (namely pushing pictures of one color and pulling pictures of the other color), which did not require them to notice the content of the crowds, their responses may inevitably have been affected by the automatically perceived threat depicted by the crowds. Additionally, their degree of avoidance may be of a dynamic nature rather than an on/off-mechanism – the more threatening faces that are present in a crowd, the faster the avoidance tendency becomes. In contrast, people without social anxiety were able to readily focus on the task at hand without being distracted by the valence of the faces. We must keep in mind, however, that in fact, the observed effects were not significant in the overall analysis and may therefore be non-existent. Therefore, replication is certainly necessary.

What remains remarkable with regard to happy faces, is the complete dissociation between explicit ratings and AAT effects. We suppose that in order to initiate such a drastic reversal of “naturally” positive valence at an automatic level, one must have had an extensive history of negative experiences, or at least many unchallenged negative interpretations in situations involving these facial expressions. Frequent negative interpretations of ambiguous social interactions probably precede the manifestation of automatic negative evaluations (compare: Heinrichs & Hofmann, 2001). This could mean that, once automaticity is established, direct cognitive accessibility might not be necessary anymore, might have become difficult, or might even be impossible. The lack of group differences in the direct rating task as well as the low correlation between the tasks seem to support that notion, though other explanations are possible. We have argued earlier (Lange et al., 2008) that while exploring the facial displays, all participants could have “logically reasoned” that friendliness ratings should decline when the number of angry faces in the crowds increases.

It is also possible that the concordance of the two groups in explicit ratings stems from social desirability effects. Socially anxious participants could have re-appraised the crowds in a way that they believed was expected from them as “good” participants (Gilbert, 2001; Osman et al., 1998; Schnabel et al., 2006). Another explanation might be that the initial, automatic threat evaluation measured with the AAT may initiate associated simple behavioral tendencies but may not be strong enough to affect controlled cognitive processes.

*Limitations*

It appears that the AAT approach might be a promising path when investigating evaluation biases in social anxiety. In fact, similar AAT effects have been observed with single emotional face stimuli (angry, neutral, happy; Heuer et al., 2007), and comparably straightforward data for social anxiety have not yet been found with non-verbal materials. Several critical issues have to be raised, however. First and foremost, the lack of statistical significance of the group-by-ratio interaction in the neutral-angry crowds limits the results considerably. Although the results make sense in the light of the reviewed literature and comparable results in a similar study (Heuer et al., 2007), we are fully aware that the conclusiveness of our findings is limited, at least for the neutral-angry crowds. Therefore, replication is certainly necessary.

The generalization of our results is also hampered by the fact that the sample consisted only of socially anxious women. In the future, it will be necessary to extend this research to a male population. Additionally, it could be that the two crowd types used here do not only differ in the number of angry faces, but also in the intensity of emotionality. In the neutral-angry crowds, additional angry faces make the crowd more negative, but also increasingly emotional. In the happy-angry crowds, the valence becomes more negative, too, but the intensity of the depicted emotions probably stays the same. In future research, it will be necessary to add different ratios of other emotional expressions to neutral crowds to disentangle these influences and to make the crowds more comparable.

Finally, the direct rating task might need some revision. Possibly, “friendliness” and “threat” are not clearly opposite enough. It might be more

straightforward to ask participants directly how threatening they find the crowds to be. Another possibility is that “friendliness” or “threat” ratings are too abstract when referring to pictures of groups. To circumvent this problem, the question could be worded in a way such that it relates more to “real threat” or anxiety. For instance, asking how intimidating one finds the group when imagining having to give a presentation in front of them, might be more ecologically valid, and may elicit diverging responses of SAs and NACs.

*Future directions*

If the AAT proves to be a reliable task for assessing biased implicit evaluations in socially anxious patients, and helpful in addition to explicit evaluation tasks, it might open up a range of future applications. It has to be investigated if the task is helpful to measure treatment effects in addition to traditional instruments for treatment outcome evaluation (compare: e.g., Teachman & Wood, 2003; for conflicting results see also: Huijding & de Jong, 2007). Another application might be to use the AAT as a therapeutic instrument making use of the bidirectional link between behavior and evaluation as suggested by Neumann, Förster and Strack (2003).

In sum, if the main theoretical and technical issues of this paradigm have been tackled, it has the capacity to shed more light on the cognitive and behavioral processes underlying social anxiety and social anxiety disorder, and it may complement the diagnostic and therapeutic instruments available in the clinical field. However, in the light of the statistical limitations, above all, replication of our results is necessary.

## Footnotes

[1] Participants were invited for the Rating Task on Day 1 and the AAT on Day 2. Not all students completing the Rating Task participated on Day 2 (AAT), which explains the different sample sizes for the two tasks.

[2] We presume that pulling and pushing responses can be carried out equally quickly. Consequently, a negative AAT effect might be interpreted as a tendency to prefer pushing the stimulus away over pulling it closer. An effect score around zero would indicate that there is no particular preference.

[3] Additional analyses of the data from only those participants who had completed both the AAT *and* the rating task yielded comparable results.

[4] In two other experiments, we also tested different facets of the direct evaluation of crowds. Manipulations of presentation time and response window never revealed any differences in ratings between socially anxious and non-anxious participants (e.g., Lange, Heuer, Langner et al., 2008).

Chapter 7

# Induced Interpretation Bias Influences Automatic Avoidance Behavior

A slightly adapted version of this chapter is submitted as: Lange, W.-G., Salemink, E., Becker, E.S., & Rinck, M. (2007). Induced interpretation bias influences automatic avoidance behavior.

## Abstract

Cognitive bias modification studies suggest a causal role of interpretation biases in the etiology and maintenance of Social Anxiety Disorder. It is unknown, however, if the effects of induced biases transfer to behavior. In an analogue study, behavioral changes in response to aversive and positive stimuli were measured after the induction of positive and negative interpretation biases in “averagely anxious” participants. Responses to emotional multi-facial displays (“crowds”) were measured using an indirect Approach-Avoidance Task. The crowds comprised different ratios of either neutral and angry faces or happy and angry faces. Negatively trained participants showed a faster avoidance response for the neutral-angry crowds when the number of angry pictures in the crowd increased. This response pattern resembles the one previously found in socially anxious individuals.

## Introduction

In the last decennia, a large body of evidence has supported the theoretical framework (e.g., Clark & Wells, 1995) that biased information processing might be crucial in the understanding of etiology and maintenance of psychiatric disorders. In fact, many recent studies have provided evidence that information-processing biases may play a causal role in anxiety disorders, but also in sub-clinical anxiety. Patients diagnosed with social phobia (for details see: American Psychiatric Association, 2000; APA), for example, are thought to hold a strong negative interpretation bias (e.g., Hirsch & Clark, 2004). Their worst fear is negative evaluation by others. Negative biases in interpretations is one of the most prominent dysfunctional information processes in social phobia (e.g., Foa et al., 2001). When participants are, for instance, asked to interpret outcomes of ambiguous social situations, findings have repeatedly shown that social anxiety seems to be associated with a more negative interpretation (e.g., Huppert, Pasupuleti, Foa, & Mathews, 2007). Moreover, Voncken, Bögels, and de Vries (2003) found that socially phobic participants tended to interpret *all* kinds of social scenarios negatively, not just ambiguous ones.

Contrary to the straightforward findings with text materials, there is less persuasive evidence when participants have to evaluate (ambiguous) facial expressions instead of social scenarios (Gilboa-Schechtman et al., 2005; Merckelbach, Van Hout et al., 1989; but also: Philippot & Douilliez, 2005; Yoon & Zinbarg, 2007). This is rather surprising when considering that facial expressions are

often ambiguous, thought to be evolutionarily routed, and seem to have communicative (thus social interactive) value (Vuilleumier, 2002). Just recently, though, it has been shown that negative evaluations or interpretations of facial expressions are reflected in automatic[1] approach and avoidance behavior, but not necessarily in controlled direct evaluations (individual pictures: Heuer et al., 2007; multifacial displays: Lange, Heuer, Langner et al., 2008). In both studies, participants had to pull emotional faces towards themselves (approach) or push them away (avoid) by means of a joystick. Even though the emotions were task-irrelevant in both studies, socially anxious participants generally showed speeded avoidance reactions to (an increasing number of) emotional faces (angry, happy). When asked to rate the same faces directly in terms of friendliness, the groups did not differ.

Just recently, researchers have started to investigate the cause-effect-chain of biases and symptoms. It is still unclear whether people are anxious and, as a symptom, develop a cognitive bias, or whether people have developed a cognitive style that might eventually, along with behavioral changes, evolve into a psychiatric disorder. As an analogy, techniques have been developed that allow for the induction of interpretation biases or attentional biases in non-anxious participants (Cognitive Bias Modulations [CBM]). An important issue regarding CBMs is whether an induced bias not only transfers to conceptually similar new materials, but whether the bias also generalizes to other domains and whether it is reflected in measures estimating anxiety or anxiety-related behavior. Recent evidence indeed suggests that induced interpretation biases (CBM-I) influence subsequently reported anxiety in response to stress, as predicted by the valence of the training (e.g., Mackintosh et al., 2006). Mathews, Ridgeway, Cook, and Yiend, (2007) showed that, in highly trait

anxious participants, a four-session benign interpretation training increased the amount of positive interpretations of novel ambiguous events. Additionally, the degree of subjectively reported trait anxiety decreased after the training. Yet, to our knowledge, to date no study has reported changes in anxiety-related behavior following such a training.

The present article reports selected data from a broader series of experiments at the University of Utrecht. While the main study investigated the effects of CBM-I on new more generalized social scenarios, and will be published elsewhere (Salemink & van den Hout, 2007), the *current* article focuses on the transfer of such an interpretation bias to anxiety-related behavior. Consequently, our research question was very specific. Since it has been shown by Lange, Keijsers, Becker et al. (2008) that facial crowds trigger automatic avoidance responses in people with elevated social anxiety, it was hypothesized that the same should be true for people who were trained to interpret social situations negatively. Specifically, in socially anxious individuals these response tendencies are known to become increasingly avoidant, when the number of angry faces increases in a neutral crowd. Moreover, socially anxious individuals also react avoidant to happy faces (e.g., Heuer, Rinck, & Becker, 2007). We therefore examined if CBM-I influences behavioral responses to emotional crowds, using the Approach-Avoidance Task (AAT) developed by Rinck and Becker (2007).

From results of earlier research, we predicted that in negatively trained participants, AAT effects would become increasingly negative (faster pushing than pulling) with an increasing number of angry faces in a neutral-angry crowd. For happy-angry crowds, we hypothesized that emotional faces as a whole are seen as

threatening by NETs and are reacted to with an avoidance response. If positive training is a good model of how healthy individuals with average anxiety levels perceive the world, they should not be influenced by the valence of the crowds because valence is irrelevant to the task.

## Method

*Participants*

After exclusion of two participants due to technical problems, 68 second-year psychology students (88.2 % female) of the University of Utrecht participated in this study. The age of the participants ranged from 19 to 31 years (*M* = 20.71; *SD* = 2.27). An experimental session lasted for about 1.5 hours for which students received course credit.

*Material & Measures*

*General*. Participants were preselected according to their trait-anxiety scores on the Dutch version of the State-Trait Anxiety inventory (Van der Ploeg, Defares, & Spielberger, 1980) that 270 students had filled in at the beginning of their study year. In order to be able to induce and detect changes in anxiety, only students with scores around the mean (between 32 and 39) were invited for the study. On the day of the experiment, before the training, participants completed a general screening instrument (handedness, education, etc.), the Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987), the state-version of the State/Trait Anxiety Inventory (here: STAI-State1), and the trait-version of the STAI (STAI-Trait). After the training, a

manipulation check followed, as well as additional measures of interpretation bias that are irrelevant for this paper. Finally, participants filled in the STAI (here: STAI-State2) and the LSAS again. Then they completed the AAT.

*Interpretation Training*. The interpretation procedure made use of text materials that have successfully been employed earlier (compare: e.g., Yiend, Mackintosh, & Mathews, 2005), in a Dutch translation utilized by Salemink, van den Hout, and Kindt (2007b). In each of eight training blocks, participants read 13 text vignettes with descriptions of ambiguous social scenes. Each scene consisted of three sentences, which could be "disambiguated" by filling in the missing letter of the last word(-fragment). After this "disambiguation", the scenes turned out to be either positive or negative, depending on the training condition. Eight of the 13 vignettes were for training purposes, but each block also contained three filler items and two probe items to monitor training effect across blocks. While the filler items were to obscure the direction of the training, the probe items were predefined (one positive, one negative) in both conditions alike, and served as manipulation check. Here, response latencies for word completion were recorded.

Participants read the vignettes sentence by sentence (self paced) on a computer monitor. When they reached the last word(-fragment) they had to fill in the missing letter. Afterwards, a comprehension question was asked to enhance the interpretation given to the meaning of the scene: e.g., "After painting the walls of your living room, you invite friends for dinner. You can see their surprise as they enter the room. They react with d _ _ _ ust/ ap _ _ _ val. " The question followed immediately after word completion: "Did your friends like your work ? (Yes/No)".

After the training phase a so called “recognition task” was introduced that served as another manipulation check, and additional social vignettes and questionnaires were used to measure transfer of the training. The details of these tasks are irrelevant here and will be described elsewhere (Salemink & van den Hout, 2007).

*Approach-Avoidance Task*. The AAT was identical to the one used by Lange, Keijsers, Becker et al. (2008). A selection of 36 color photos of 12 individuals (all male), each one presenting three different expressions: angry, neutral and happy, was taken from the Karolinska Directed Emotional Faces database (Lundqvist et al., 1998). Matrices of 12 (4 ×3) facial expressions were constructed to vary in the degree of social approval/disapproval. Two types of crowds were created: Neutral-angry combinations and happy-angry combinations. The degree of threat was varied by gradually manipulating the ratio between pictures of the two target expressions of each crowd. Seven different ratios were composed: 12:0 (e.g., 12 neutral and zero angry pictures), 11:1, 9:3, 6:6, 3:9, 1:11, and 0:12. Each individual and emotional expression was randomly presented at any position. Every matrix was constructed in two different color shadings (here: reddish, brownish) and in seven different sizes ranging from 200 × 202 pixels to 760 × 768 pixels.

*Procedure*

When entering the laboratory, participants vested informed consent before being seated approximately 50 cm from a computer monitor in a soundproof cubicle completing a first set of questionnaires. They started with the general screening questions, the LSAS, the STAI-State1, and the STAI-Trait. Then they were randomly

assigned to the positive interpretation training (POT) or the negative interpretation training (NET) and started the retraining program by pressing the keyboard's space bar. A first sentence appeared on the screen and participants could advance to the next sentence until the word fragment was presented. As soon as they recognized the word, they were asked to press the space bar, and then type the first missing letter. If the answer was correct, the full word appeared for one second in blue letters. Otherwise the word appeared in red letters. In any case the next trial started afterwards. Then, the comprehension question was presented, which could be answered with "yes" or "no". Again color feedback was given and the next trial started. After the training, participants filled in the STAI-State2 and the LSAS again, completed the recognition task and the social vignette questionnaires. Then, for the AAT, a standard computer joystick was located 25 cm between them and the monitor. The participants were asked to either push or pull the joystick depending on the color shading of the appearing multi-facial display (called "crowds") as quickly as possible, until the display disappeared. On each self-paced trial, a display appeared in medium size. When the joystick was pulled, the display increased in size to give the impression of pulling the crowd closer. Pulling all the way would make the display disappear. When pushing the joystick, the size of the display decreased in size to give the impression that the crowd was pushed away. Here, the display disappeared when the joystick was pushed all the way.

Participants were given 24 practice trials, before completing two blocks of 168 experimental trials each. The instructions concerning pulling and pushing the joystick in relation to the shading of the display (brown = push and red = pull vs. brown = pull and red = push) were counterbalanced across participants.

The sequence of a trial was as follows: the black screen was blank until the “fire”-button of the joystick was pushed. Then the crowd appeared in its initial medium size, having either a reddish or a brownish shading. Whenever the joystick was moved the display size changed accordingly. The display disappeared when the joystick reached one of the end positions. RT measurement started upon presentation of the crowd, was recorded at all intermediate positions and stopped at the end position when the crowd disappeared. Then the participant started the next trial by moving the joystick back to the central position and pushing the button. At the end, participants were debriefed, compensated for their effort, and thanked for their participation.

**Results**

*Training effects & manipulation checks.* The main measure to control whether the manipulation worked was the reaction time (RT) in response to the probes. A 2 (direction of training: negative, positive) × 2 (probe valence: negative, positive) repeated measures ANOVA was used to analyze the RTs. This ANOVA revealed that the expected training × probe valence interaction was significant, $F(1, 66) = 14.11$, $p < .001$. As expected, POTs tended to be faster than NETs when responding to *positive* probes ($M_{POT}$ = 1139 ms, $SD_{POT}$ = 53 ms vs. $M_{NET}$ = 1267 ms, $SD_{NET}$ = 53 ms), while both groups reacted about equally fast to negative probes ($M_{POT}$ = 1316 ms, $SD_{POT}$ = 53 ms vs. $M_{NET}$ = 1273 ms, $SD_{NET}$ = 53 ms).

From the above, it can be concluded that the manipulation basically worked, and that participant reacted to valenced materials as would be expected from the

training. Similar conclusions can be drawn from additional manipulation checks reported by Salemink, et al. (2007).

*AAT effects in general.* AAT effects were calculated by subtracting each individual's median RT for pulling a certain kind of crowd from the median RT for pushing it. The resulting difference scores were entered into an ANOVA. A main effect for crowd type, $F(1, 66) = 20.46$, MSE = 6944.29, $p < .001$, and a significant training × crowd type × expression ratio interaction, $F(6, 396) = 2.19$, MSE = 7095.62, $p = .04$, indicated that the two crowd types were substantially different. Additionally, we were more interested in the degree of response change with an increasing number of angry faces than in the individual contribution of single ratios. Therefore, responses to both crowd types were analyzed separately by means of a linear regression analysis.

*AAT effects for neutral-angry crowds.* The linear regression analysis revealed a trend for the training × ratio interaction, $\beta = 3.21$, $SD = 1.80$, $t(66) = 1.78$, $p = .08$. When regression lines were analyzed separately, the slope of NETs differed

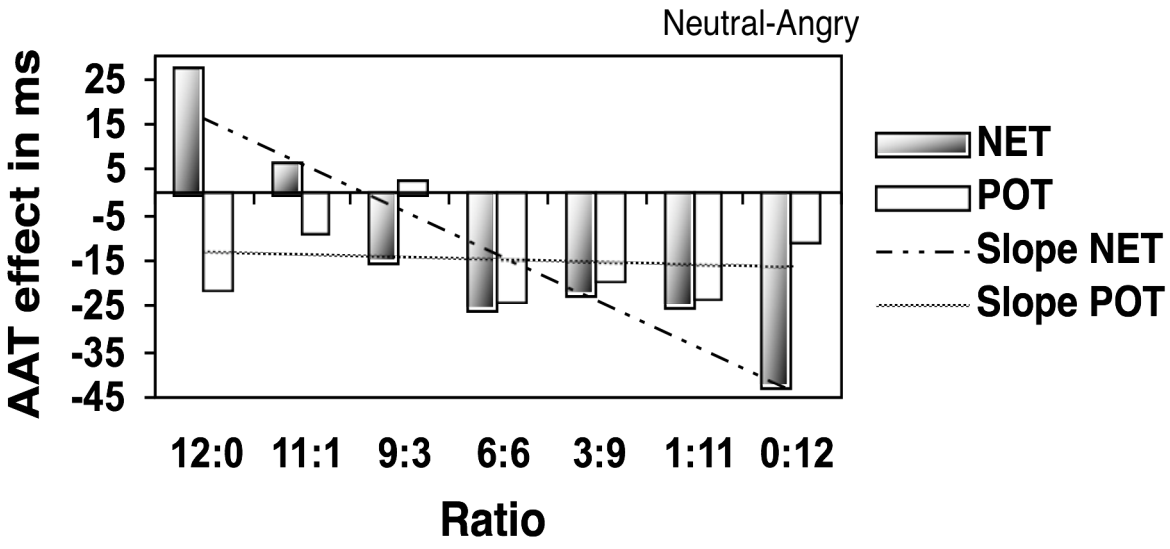


**Figure 7.1** *Mean AAT-Effects in milliseconds for neutral-angry crowds per ratio per group.*

significantly from zero, $F(1, 33) = 10.55$, MSE = 8267.51, $p < .01$, while the same assumption for the POTs was rejected, $F(1, 33) < 1$, MSE = 3929.42, $p = .31$. This suggests that only the NETs became more avoidant as the number of angry faces in a neutral-angry crowd increased (Figure 7.1).

*AAT effects for happy-angry crowds.* In contrast to the angry-neutral crowds, analyses of the slopes revealed no differences between NETs and POTs. The linear regression confirmed that the interaction between training and ratio, $\beta = -2.14$, $SD = 1.62$, $t(64) = -1.38$, $p = .19$, was not significant. Additionally, NETs' slope did not differ significantly from zero, $F(1, 33) < 1$, MSE = 5066.19, $p = .51$, nor did the slope for the POTs, $F(1, 33) = 2.76$, MSE = 7315.69, $p = .11$. It seems that the training did not change participants' behavior towards happy-angry crowds (Figure 7.2).

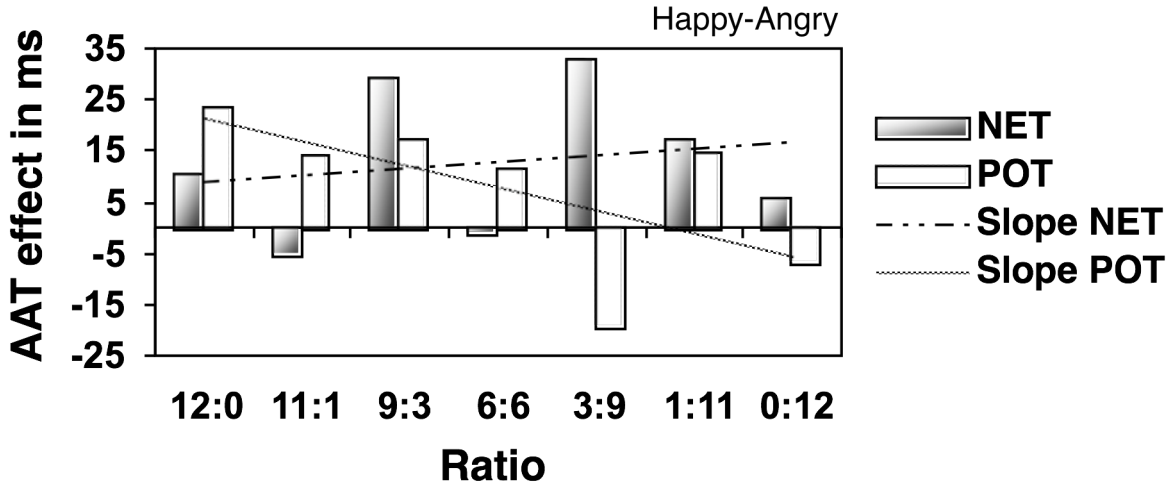


**Figure 7.2** *Mean AAT-effects in milliseconds for happy-angry crowds per ratio per group.*

## Discussion

In the present study, we investigated if an induced interpretation bias/cognitive bias modulation evokes changes in approach-avoidance tendencies towards emotional crowds. The results show that an induced negative interpretation bias influenced subsequent automatic behavior impulses, depending on the types of emotional expressions combined in multi-facial displays. Importantly, the influence of the bias on behavior was highly dependent on the types of emotions combined (crowd types). The combination of neutral and angry emotional expressions in a crowd revealed the most striking results. With an increasing number of angry faces in a crowd, the group trained to endorse negative interpretations of social situations, became faster in pushing the crowds away (avoidance) than in pulling them closer (approach). This supports the notion that with an increasing number of angry faces, NETs tend to perceive or interpret the crowd as increasingly aversive, similar to socially anxious participants (compare: Lange, Keijsers, Becker et al., 2008). In contrast, POTs did not show such a pattern. The slope of their AAT effects did not significantly differ from zero. In all stimulus configurations, their pushing was as fast as their pulling. Apparently, the POTs did not have any distracting evaluative perception or interpretation affecting their behavior. In other words, they followed the instructions to respond to the pictures' color shading, and they were unaffected by the irrelevant emotional dimension. In the happy and angry face combination, no differences between the two training groups could be observed.

So far, we can conclude that the induction of a negative interpretation bias that is related to social scenarios, influences initial automatic behavior tendencies in

response to pictures of angry facial expressions in group displays. From the observed patterns, it is concluded that an increasing number of angry faces in a neutral group initiates an immediate automatic avoidance response comparable to that observed in socially anxious participants (Heuer et al., 2007; Lange, Keijsers, Becker et al., 2008). The responses to positive faces remain unchanged, as the behavior in reaction to both crowd types by positively trained participants.

It seems that the induction of cognitive biases might be a promising path when investigating the cause-effect chain in psychiatric disorders in general, and interpretation biases in social anxiety in particular. In fact, comparably straightforward data indicating changes in anxiety-related behavior due to a generalization of cognitive retraining have not been found in a non-clinical sample before and need further exploration. Nevertheless, several critical remarks and questions have to be raised. Due to the lengthy set-up of the experimental series (not all parts and results reported here), interpretation biases and AAT scores were not measured before the training. Thus, unfortunately no base line could be established. Seemingly, the results of manipulation check imply that participants who received a *positive* interpretation training behaved according to the valence of the training. Without a baseline, though, this is not a valid conclusion. As a matter of fact, the AAT results suggest the contrary. Here, it seems that mainly the negatively trained participants were influenced in their behavior. Additionally, all participants had an “average” degree of anxiety proneness before training. The literature suggests that non-anxious participants may as well have a positive interpretation bias “protecting” them from psychopathology (e.g., Matthew Garner, Mogg, & Bradley, 2006). Taking this into account, it is plausible to assume that the negatively

trained participants in the recent study were *deprived* of their formerly positive bias. This could explain why they did not show significant reaction time differences for positive compared to negative probes or why they did not show significant "recognition differences" (reported in: Salemink & van den Hout, 2007) for negative as compared to positive interpretation options. Positively trained participants did show these differences and it appeared as if *they* were the ones profiting from the training, even though they might simply have been doing what they always do: prefer positive interpretations. For the AAT, even if evaluation of the pictures becomes more positive, it would remain task-irrelevant. Threat detection might after all be evolutionarily more significant than the detection of friendly faces.

Another point of interest must be the absence of any response tendency differences in the happy-angry crowds. If the induction of a negative interpretation bias mimics the interpretations in social anxiety, and if happy faces are implicitly negative, one would expect that response patterns for happy-angry crowds would resemble those by socially anxious, too (compare: Heuer et al., 2007; Lange, Keijsers, Becker et al., 2008). However, they do not. A possible explanation could be that the generalization of an induced cognitive bias towards automatic behavior works better towards "logically" congruent material. It is likely that angry faces are naturally more threatening than happy faces and that only the long learning history of socially anxious individuals has made them perceive the valence of ("naturally" positive; Preuschoft & van Hooff, 1997) happy faces as threatening. In contrast, a negative interpretation training might be capable of pushing the implicit threat evaluation above a certain "relevance" threshold. The training might be too weak, though, to reverse the inert "positiveness" of a happy face within an hour.

Additionally, the working mechanism of a positive training is unclear. The observation of a positive bias in non-anxious controls is normally less specific and not restricted to social scenarios. This makes the selection of training items more difficult, and if kept purely social, too specific to generalize to other domains. Besides, we do not know what happens when someone with a positive bias is trained to think even more positively, and if we are encountering a ceiling effect. Ideally, interpretation training would have to work both ways, and transfer to related behavior should be bidirectional. Besides that, we have to be aware that the sample in this analogue study was non-clinical, and that we attempted to induce a bias in order to simulate the consequences for novel interpretations, anxiety, and associated behavior, as a model of social anxiety. Whether benign interpretation training has the potential to reduce negative biases in clinically anxious patients, and whether such a training reduces automatic avoidance tendencies towards emotional faces, has to be determined by future research.

In sum, the results show that CBM transfers to (automatic) anxiety-related behavior. Nevertheless, more questions are raised than answered. On the one hand, they show that training an interpretation bias can influence automatic avoidance tendencies. By doing so, the negative training serves as an analogue model for understanding social anxiety disorder and shed more light on the cognitive and behavioral processes underlying social anxiety and social phobia. Considering this, it is likely that, rather than merely being a symptom, cognitive biases might be initiating factors in bringing about psychiatric disorders. On the other hand, it remains unclear what effects positive interpretation training brings about, and whether it could serve as therapeutic means for the treatment of social anxiety disorder. This would have to

be evaluated by testing participants who already show a negative bias, and by comparing bias and behavior measures before and after a positive training.

## Footnotes

[1] For a critical discussion of the term “automatic”, see Moors and De Houwer (2006).

Chapter 8

# General Discussion

About thirty years ago, distortions in information processing have been identified to be a key component of emotional disorders (Beck, 1976), and as such integrated in a first model for treatment. Since then it has been claimed that individuals suffering from anxiety disorders, for example, share a misconception about how threatening an object, situation, or sensation really is and that they process threat-relevant information preferentially (Dalgleish & Watts, 1990; Huppert & Foa, 2004). These so called cognitive biases are subdivided into a number of different phenomena: e.g., negative (mis-)interpretation of ambiguous situations or sensations (interpretation bias), the tendency to evaluate situations and their outcomes as negative/threatening and the likelihood of their occurrence as highly probable (evaluation or judgmental bias), and the rapid detection of seemingly threatening stimuli (attention bias: hyper-vigilance). In recent years, the cognitive processes underlying anxiety have come more into focus. Cognitive theories for social anxiety disorder (SAD) such as the one of Beck and Clark (1997; but also: Clark & Wells, 1995; Rapee & Heimberg, 1997) have stressed that biases in the information processing of social cues in patients diagnosed with SAD might contribute to the maintenance and maybe even etiology of the disorder (e.g., Heinrichs & Hofmann, 2001; Hirsch & Clark, 2004). Presently there is cumulative experimental evidence to strengthen that claim (Foa et al., 1996; Hirsch & Clark, 2004; Hofmann, 2007; MacLeod, Campbell, Rutherford, & Wilson, 2004; Mathews & MacLeod, 1994; Stopa & Clark, 1993; Yiend & Mackintosh, 2004). Even though facial expressions are undoubted strong, readily misinterpreted social signals, it is insufficiently clear if, in social phobia, they are target of negative interpretations, are preferentially processed, and evoke social evaluative stress.

This thesis investigated in how far (particular) facial expressions are subject to preferential attentional processing, misinterpretations or -evaluations, such as being threatening and anxiety confirming for individuals with elevated degrees of social anxiety. Six different approaches have been selected to gain insight in biased processing of facial expressions and the correlation with high levels of social anxiety.

## Biased attention to attentional bias

First, we aimed in a more general setup to explore if threatening stimuli such as spiders and angry faces affected an attentional phenomenon called Inhibition of Return (IOR; Berlucchi, 2006; Posner & Cohen, 1984). IOR prioritizes visual attention to stimuli in a new spatial location over stimuli in previously scanned spatial locations. This phenomenon is supposed to promote novelty in the visual field and make attentional processes more efficacious (compare: Lupianez et al., 2006). If, on the other hand, detection of threat is prioritized in order to prepare an organism for quick appropriate responses (Öhman, 1993; Öhman, Flykt et al., 2001), threatening stimuli in the previously scanned location might nevertheless catch attention, and IOR might be undermined (Fox et al., 2002). In Chapter 2, we explored that notion. Contrary to findings from e.g., Fox et al. (2002), none of our experiments confirmed the hypothesis that IOR is reduced or absent when threatening stimuli are presented prior to the target stimuli, neither in unselected participants, spider fearfuls, nor in socially anxious individuals (SAs) or non-anxious controls (NACs). In fact literature does provide only limited examples of altered IOR for fear related stimuli. Instead it is believed that "… IOR is a 'blind' mechanism that is unaffected by the mere

occurrence of biologically relevant cue and target stimuli" (Taylor & Therrien, 2005; p. 1414). As our implementation of a variety of threat stimuli could not evoke any disruptions of IOR throughout a series of experiments we believe that IOR is insensitive to the valence of the utilized cues. Our results imply that IOR is largely determined by "bottom-up" perceptual information (compare: Berlucchi, 2006; Possamai, 1986; Tassinari et al., 1989). Specific perceptual features/energy changes in the visuospatial field appear to lead to the inhibition of attention of a specific locus during a short period of time. Since stimulus valence is controlled "top-down", however, it might not have had the time to interfere with the bottom-up process. The presented experimental set-up does not allow a conclusion about preferential attentional processing of threat stimuli in general. We can only conclude that a basic attentional process, such as IOR, does not seem to be affected by stimulus valence.

In Chapter 3 and in a series of unpublished studies, we explored the attentional processing of facial expressions more directly. From our results (Chapter 2) we concluded that angry faces may not be threatening enough to catch attention in a way that undermines robust attentional processes such as IOR. The assumption that, once threat is detected in the visual field, it may be difficult to disengage attention from (Fox et al., 2002; Georgiou et al., 2005; Koster, De Raedt, Goeleven, Franck, & Crombez, 2005; Salemink et al., 2007a), led to a more straightforward exploration of the attentional properties of facial expressions. We conducted three experiments, varying a promising disengagement paradigm developed by Fox and colleagues (2001; Experiment 5). SAs and NACs were asked to identify/categorize letters flashed in the periphery of a centrally presented facial expression. Thus, first a

facial expression was centrally presented. While the face was still visible, a letter, either an “R” or a “B”, was presented on the screen on one of 8 different randomized positions with a radius of 5 or 13 cm. Participants had to decide as quickly as possible which letter they had seen. According to theory, angry faces should hold attention (of socially anxious individuals) longer than other faces, and thereby disrupt reaction times and/or percentage correct responses. Alternatively, Christianson (1992; Wessel et al., 2000) introduced the term “attentional narrowing” to discribe disengagement-related phenomena. If the diameter of the attentional focus constricts in response to a threat cue, naturally, other stimuli in proximate spatial locations fall beyond the focus and are difficult to detect - response latencies increase. Though disrupted disengagement is frequently reported with trait- and state anxious individuals (Fox et al., 2001 for word stimuli; Georgiou et al., 2005 for fearful face stimuli), we were unable to find increased “dwell-times” for centrally presented angry faces, neither in NACs nor in SAs (unpublished: Lange, Keijsers, Rinck, & Becker, 2007). In fact to our knowledge, we are the first using this paradigm in a socially anxious population, disconfirming that angry facial expressions hold attention longer than neutral or happy expressions. From the above we conclude that not only automated processes such as IOR but also probe detection in general, might be based on bottom-up processing and remain relatively unaffected by top-down influences such as threat evaluation (e.g., Berlucchi, 2006). Thus, it is possible that alterations of stimulus processing by means of its changing valence are dependent on their relevance for fulfilling the task. For example, in order to improve task performance in Chapter 2, thorough processing of the (valenced) cue was unnecessary. In our disengagement-study described above we may have failed to

find disrupted disengagement because the centrally presented stimulus was again irrelevant for task completion.

To test the notion of attentional capture and attentional narrowing in a paradigm with more *task-relevant* valenced material, a flanker task was employed in Chapter 3. The emotion of a target picture had to be categorized into angry, happy, or neutral, while the flanking faces had to be ignored. If threatening faces would indeed capture attention than the participants' responses should be delayed for angry flankers when the target face was happy or neutral. Theory (e.g., Eriksen & Eriksen, 1974) suggests that flankers that are similar or equal to the target, are less distracting than flankers that differ from the target. But, if a target is identified as threatening it should initiate attentional narrowing. Consequently, the influence of differing as opposed to equal flankers should be diminished (Fenske & Eastwood, 2003). Since angry faces are supposed to be highly threatening to SAs, SAs were expected to show clear effects of attentional narrowing. However, our findings did not show any effect of angry faces, neither as flankers nor as targets. Social anxiety was not relevant for any of the effects, either. Thus, even if task-relevant, responses to threatening flankers or targets did not elicit preferential processing, neither through distraction nor through narrowed focusing. Unexpectedly, however, we found an interaction of target gender and target emotion. Pictures of smiling females and angry males were faster categorized than angry females and smiling males. Though irrelevant for a better understanding of face processing in social anxiety, these findings do have important methodological implications for research utilizing facial expressions of different genders. The implications are discussed in detail in Chapter 3. In general, our results could convey that threatening facial expressions

are probably not perceived threatening enough to distract attention from a task such as emotion categorization. Similarly, the impact of flanker-target similarity did not decrease when an angry target had to be processed. Thus, no (detectable) attentional narrowing took place. In sum, our findings from Chapter 2 and 3 as well as from our unpublished study, do not evidence any attention-capturing capacity of angry facial expression that brought forth either distraction or speeding of responses, nor did angry faces evoke any attentional narrowing. Thus, even if the processing of the stimulus is task-relevant and top-down control enabled (Chapter 3), angry faces are not apt to attract attentional resources quicker or longer than neutral or happy faces. With these results we are in line with findings from Bradley et al. (2000; but also: Moser, Huppert, Duval, & Simons, 2008; Pineles & Mineka, 2005). On the other hand our data contradict evidence of a bias *towards* (negative) faces of e.g., Maieritsch & Walter (2003; but also: Mogg & Bradley, 2002a; Mogg et al., 2004; Sposari & Rapee, 2007), but contradict also evidence for a bias *away* from (negative/emotional) faces (Chen et al., 2002; Mansell et al., 1999; Stirling et al., 2006).

Both, the lack of vigilance to as well as the lack of distraction by angry facial expressions contradicts not only results from visual probe literature but also findings with visual search tasks such as e.g., the “face-in-the-crowd” paradigm (e.g., Gilboa-Schechtman et al., 1999; Hansen & Hansen, 1988). The employment of this procedure has repeatedly evidenced an “anger superiority effect” in normal controls but also in trait anxious participants: detection times of, e.g., angry faces in a group of happy faces (crowd) appear much shorter than the other way around. However, even within the visual search literature, findings are quite equivocal especially when

participants are selected on degree of social anxiety. Eastwood et al. (2005) used schematic faces (“smileys”) and found an attentional bias towards negative faces for social phobic participants. Gilboa-Schechtman, Foa, and Amir (1999) utilized crowds composed of the same individual depicting *one* deviant expression. She did find the anger-superiority effect in socially phobic individuals, too, but also found distraction by happy expressions. Juth, Lundqvist, Karlsson, & Öhman (2005) found an anger-superiority effect with schematic faces, and only in the accuracy not in the reaction time data. Besides that, anger was only detected more accurately by socially anxious participants, when embedded in emotional distractors and when under conditions of socio-evaluative stress. For real faces (all different individuals) she found a happy-superiority effect independent of anxiety levels. These inconsistencies can have many reasons. Hahn and Gronlund (2007) argued that task difficulty and instructions influence presence or absence of a processing advantage for threat. Taken together in seems though that in visual search, individuals with a high degree of social anxiety may exceed the superior accuracy for searching angry faces in a crowd that normal controls show. Interestingly, Horstmann (2007) remarked that a systematic anger-superiority effect is no proof of an enhanced preconscious processing of angry faces. In fact, mere negative evaluation of angry faces (in social anxious individuals) would make a fast detection of angry faces in a crowd as plausible. Thus, if no threat-evaluation takes place, covert attentional processes calibrated to detect danger may not be activated as our results so far have demonstrated. The negative evaluation of a particular category of facial expressions can nevertheless lead to speeded detection as the visual search literature proves.

In sum, our results so far suggest that emotional faces are not evaluated as threatening by SA and as such do not interfere with threat-related attentional processes. We believe, though, that they might be special for some individuals (with elevated degrees of social anxiety) but not for others. Even though certain emotional faces are not necessarily evaluated as threatening they are nevertheless evaluated as strikingly negative. Consequently, cognitive distortions may manifest themselves on another domain of processing then studied thus far in the present thesis: not during quick feature or (threat-)valence detection, but on the contrary, during slower more evaluation-related responding to (negative) emotional faces.

## Response Bias or Interpretation Bias ?

In the previous paragraph it has been concluded that mere negative evaluation of facial expressions might stem from different cognitive processes than threat evaluations do. For the occurrence of a negative evaluation, for example, it is necessary that an expression is factually recognized or at least conjecturally recognized, and quickly (negatively) interpreted. In Chapter 4 our attention shifted to the question whether social anxiety is perhaps associated with an altered detection of facial affect *change* in others. While the social skills deficit model suggests that socially anxious individuals may lack a variety of skills needed in social interactions they may be poor at recognizing emotional change in others, too (e.g., Stopa & Clark, 1993). Others propose, however, that SA might be *superior* in recognizing negative affect as it is relevant to their fear and thus threatening to them (compare: Joormann & Gotlib, 2006; Silvia, Allan, Beauchamp, Maschauer, & Workman, 2006).

In addition, it is suggested that these described processes might be joined by (speeded) jumping to negative conclusions (e.g., Winton et al., 1995).

We constructed the following experiment to explore whether SAs' and NACs' recognition of gradually changing facial expressions differ. Short film clips made of two photos morphed (compare: Joormann & Gotlib, 2006; Niedenthal et al., 2002) from neutral to emotional (angry, happy, or disgust), had to be stopped when the participant thought to have detected emotional change. Then, without getting the opportunity to see the full emotional expression, participants were asked to decide which emotion they thought would develop from the features they had seen (Chapter 4, Restricted Viewing Task [RVT]). In the second part of the study participant were allowed to freely move forward and backward through the whole film clip. They were asked to determine the point at which the emotion became visible and to guess the depicted expression shown in the end (Free viewing Task [FVT]). There was only tendentious evidence for a generally slowed detection of emotional change in SA under the restricted conditions of the RVT. Instead, we found that, under restricted viewing conditions, socially anxious participants when in error, mistake first signs of disgust expressions for depicting contempt. NACs, when mistaken, rather interpreted the first signs of disgust as those of a happy expression. Thus, not the *number* of errors (per emotion) differed between the groups, but the *kind* of error. The FVT did not reveal any differences attributable to any emotion in particular or to social anxiety. Our results contradict those of Joormann & Gotlib (2006). With a comparable experimental design, they found that social phobic individuals were considerably faster in identifying developing angry expressions than were depressed participants or normal controls. It is difficult to explain those differences in findings.

Despite the similarities between the two approaches, there are, numerous methodological difference that could have led to the results, as discussed in more detail in Chapter 4. Most prominently, the depicted change in our movies was much more gradual (1 vs 2 % steps), thus more difficult to detect, and we had no emotion repeated by the same actor. From the longer RTs as well as the higher error rates in our RVT, it appears as if our task was much more difficult than that of Joormann & Gotlib (2006). In absence of comparable experimental data in the literature, we have to conclude that under conditions of slow emotional change, participants did not show individual differences with regard to recognition speed or accuracy.

In sum, this study did not support the notion that socially anxious individuals are exceedingly good/fast at identifying emotional expressions in others (for conflicting results see: Joormann & Gotlib, 2006). Additionally, they do not lack the skill to correctly recognize emotional facial expressions as might be deduced from the social skills deficit model (Alden & Wallace, 1995; Ashbaugh et al., 2005; Foa et al., 2001). It is more likely that a continuous valence evaluation/interpretation mechanism as suggested by Mogg & Bradley (1998) hampers a quick decision of SAs in a performance situation. As this very same mechanism is believed to be fine-tuned by genetic setup as well as past experiences and cognitive set (Mogg & Bradley, 1998), it might be responsible for a misinterpretation of disgust features as contempt. In fact, it is possible that disgust is the most ambiguous of the employed emotions during the task. Philippot and Douilliez (2005), and also Darwin (1872) stressed the close relationship between disgust and contempt and their possible link with social rejection. As cognitive models of social phobia suggest that social anxiety is related to a tendency to interpret ambiguous social information as negative or

even threatening (Clark & Wells, 1995; Rapee & Heimberg, 1997) it is possible that our results hint on such a process. However, evidence for misinterpretation or negative evaluation of facial expression is equivocal so far (e.g., Merckelbach et al., 1989). If reported, distortions seem to be rather elicited under conditions of restricted processing (e.g., short presentation times, short response frame, etc.) but not under conditions of free processing (e.g., Philippot & Douilliez, 2005). From our results we conclude that constrictions of the processing itself (time pressure), difficulty of the task (very slow change) resulted in an artificial increase of ambiguity and hence facilitated the misinterpretation of the already ambiguous expression of disgust in SA. To explore how negative interpretation bridges the gap between our previous findings, it is necessary to investigate how automatic processing (e.g., eye movement) relates to evaluative processing, and how both relate to social anxiety.

## Following the eye of the beholder

In none of the preceding studies we were able to show that socially anxious individuals process emotional faces as if they were *highly* threatening or at least "special". Compared to NACs, angry faces did not undermine the IOR effect (Chapter 2), disrupt disengagement (formerly unpublished), distract when in the periphery of visual focus, or facilitate when in focus (Chapter 3), and were not detected more easily when gradually developing (Chapter 4) in SAs. What has been shown, though, was that especially angry male faces are processed more quickly, and that, faces showing disgust are misinterpreted by socially anxious individuals, as depicting contempt.

After refining the essence of the previous study we focused on the link between increased ambiguity and direct evaluations/interpretations. In order to investigate how (socially anxious) individuals visually explore a mixed (read: ambiguous) emotional crowd, we recorded eye movements while participants saw a crowd for either 500 or 2500 milliseconds. In addition, they had to rate the presented crowd in terms of friendliness when the display had disappeared (compare: Gilboa-Schechtman et al., 2005). Generally, the best predictor for the ratings was the percentage fixated angry faces of all fixations: As the proportion angry faces of all seen faces increased, the crowds were rated as less friendly. It seemed though that the proportion fixated angry faces was slightly higher in SA, but this did not lead to more negative ratings. Social anxiety did also influence the duration of the first fixation when it was on an angry face. NACs looked longer at first fixated angry faces than did SAs. This circumstance could be interpreted as attentional avoidance, though Calvo, Avero, and Lundqvist (2006) construed comparable results differently. They recorded eye movement data while participants completed a “classical” face in the crowd task (e.g., Hansen & Hansen, 1988). Even though participants looked shorter at angry faces, they were more accurate *and* faster at identifying a neutral crowd as “deviant” when it comprised an angry face as compared to a happy or a sad target face. Calvo and colleagues (2006) concluded that angry faces may be preprocessed preattentively which may have facilitated task performance and decreased fixation times. From our data we cannot rule out that any differential preattentional processing took place in SAs or NACs. Yet, if it did, crowd ratings neither in SAs nor in NACs, were object to its diverging influence.

In line with findings from Douilliez & Philippot (2003; and: Heuer et al., 2007; Kolassa, Kolassa, Musial, & Miltner, 2007; Lissek et al., 2008; Merckelbach, van Hout, van den Hout, & Mersch, 1989; Van Hout, Merckelbach, & Mersch, 1991) but in contrast to Gilboa-Schechtman et al. (2005; but also: Amir et al., 2005, Dimberg & Thunberg, 2007, MacKinnon & MacIntyre, 2007), we demonstrated in Chapter 5 that ratings of emotional facial crowds did *not* differ between SAs and NACs. In addition, threat-related processes, such as vigilance for angry faces, were only tendentiously evident. The only evidence for differential processing was based on shorter gaze durations of SAs on first fixations when they were on angry faces. When considering overt attention, it appears as if angry faces *do* initiate some form of differential attentional processing in SAs. These differences however did under no circumstance correlate with the direct ratings. It remains unclear whether this biased processing is based on *threat*-evaluations and becomes relevant for anxiety prone behavior such as negative self-evaluation, negative evaluation of social scenes, or avoidance of social situations. Our results reflect the inconsistencies in the literature and suggest that assessing biased evaluation of facial expressions by direct ratings might not be the most promising path to go. They indicate, however, that evaluative mechanisms not detectible with explicit ratings could initiate an automatic behavior reflected in avoidance tendencies in response to facial crowds.

## A Tendency to Avoid

In anxiety disorders avoidance of the feared object, or situation is quite common. In fact, learning theories (e.g., Seligman, 1971), but also cognitive theories (e.g., Beck & Clark, 1997; Hofmann, 2007; Rapee & Heimberg, 1997), assume that avoidance is a maintaining factor in the etiology of anxiety disorders. In general, anxious people know what they fear when approaching a feared stimulus and they are aware that they deliberately avoid it whenever possible. It is suggested, however, that avoidance may extend beyond conscious processing (Chen & Bargh, 1999; Foa et al., 2001; Marsh, Ambady, & Kleck, 2005; Rinck & Becker, 2007). Spider phobic individuals, for example, show an attentional vigilance-avoidance pattern: They quickly detect a spider in a display of mixed stimuli, but avoid looking at it afterwards (Pflugshaupt et al., 2005; Rinck & Becker, 2004). Similarly, Amir, Foa, and Coles (1998a) found that social phobic individuals have a tendency to preferentially process potentially threatening social sentences fast, but strategically avoid the threat later on. To test the notion that negative evaluation of facial expressions in socially anxious might rather be reflected in automatic action tendencies than in direct evaluation, the following twofold experiment was set up: We confronted SAs and NACs with a matrix of face stimuli (crowds; compare: Chapter 5) with changing ratios of neutral-angry, or happy-angry combinations. The participants were asked not to respond to the emotional valence but to the background color of the crowds. Nevertheless, our results showed that approach-avoidance tendencies, as measured by the speed of joystick movements (pulling closer vs. pushing away; see also: Rinck & Becker, 2007), were influenced by the crowd composition. SAs as compared

to NACs became more avoidant as more angry faces composed the crowd. Interestingly, happy-angry combinations were avoided as a whole, independent of ratio. This holds true even for purely happy crowds. It seems that happy faces where perceived as similarly negative/threatening than angry faces (see also: Heuer et al., 2007). These results differed from those of the explicit crowd ratings in a surprising way. When rated explicitly, in both groups, all-smiling crowds were considered positive, and the crowd ratings decreased with an increasing number of angry faces in the crowds.

In contrast to the findings from Chapter 2-5, we now have results allowing much clearer inferences about the way socially anxious individuals react to emotional faces. First, there was no proof that angry facial expressions elicited any kind of attentional vigilance or disrupted disengagement, neither in non-anxious controls nor in socially anxious participants. Second, when rated directly, angry faces are evaluated as negative, neutral faces as neutral and smiling faces as positive (compare Chapter 5). Here, the degree of social anxiety did not play any relevant role (for conflicting results see: Gilboa-Schechtman et al., 2005). Third, unlike proposed by interpretation bias literature, ambiguous neutral expressions are not interpreted as more unfriendly nor reacted to in a more avoidant way. Instead disgust is interpreted as contempt, but only under conditions of highly increased ambiguity. Fourth, when indirectly measuring approach-avoidance tendencies, it appeared that it was not possible for SAs to ignore the emotional content of the crowds whereas NACs were able to do so. Only SAs became more avoidant as more angry faces were in a neutral crowd. Fifth, social anxiety was also associated with avoidance of happy faces, which contradicted the results of the positive direct ratings. From these

results it can be concluded that social anxiety is associated with an initial avoidance response concerning emotional faces. Even generally positive faces such as a smiling one, are avoided (see also: Heuer et al., 2007). It appears rather unlikely that a happy face is evolutionarily preprogrammed to be experienced as threatening (Becker et al., 2007). Continuous negative experiences or the relentless negative interpretation of a smile (e.g., laughing about me), on the other hand, could result in a steadily increasing aversion in SA. On a conscious level, though, he or she acknowledges that a smile is positive. Cognitive theories are vague about whether an aversion, build up by repeated negative experiences, eventually develops into a threat inference. From our studies we conclude that it may not be necessary that a *threat* evaluation has to take place in order to initiate avoidance; a negative evaluation might be sufficient. To investigate the implications of our results we decided to teach non-anxious or "averagely" anxious individuals to interpret (ambiguous) social scenes as negative (or positive) and examine whether avoidance tendencies regarding emotional facial crowds change.

## The causal role of misinterpretation

It has been stressed in recent years that cognitive biases might be causally related to the development of emotional disorders (Mackintosh et al., 2006; MacLeod et al., 2004). Thus, having a tendency to evaluate one's environment as threatening and to selectively adopt threat-confirming information, might eventually contribute to the development of an anxiety disorder. Cognitive bias manipulations (CBMs) as for example the induction of an interpretation bias (CBM-I) in "averagely anxious"

individuals have shed light on the cause-effect chain in question. Many researchers have attempted to induce a negative CBM-I in participants and have indeed found an increase in subjectively reported anxiety (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002; Mathews & Mackintosh, 2000; Yiend et al., 2005). With a more therapeutic application in mind, others have experimented with the induction of a benign CBM-I in participants reporting high (but sub-clinical) degrees of trait- and social anxiety (Mathews et al., 2007; Murphy et al., 2007). Indeed, after four sessions of training, the subjectively reported trait anxiety scores decreased. It is unknown, however, in how far such training effects transfer to observable and measurable behavior. This is important, though, when one attempts to create a meaningful analogue for anxiety proneness or for specific therapeutic interventions. After all, high degrees of (trait) anxiety are usually reflected in some kind of behavior beyond eye movement, covert attentional vigilance/avoidance, or tendencies to negatively interpret vignettes of social scenes. In fact, patients suffering from social anxiety disorder tend to avoid feared social situations, or show behaviors mistakenly presumed to down-regulate or conceal their anxiety (Clark & Wells, 1995; Hofmann, 2007; Voncken, Alden, & Bögels, 2006). In Chapter 7, we reported how a common CBM-I influenced a measure of automatic behavior (Approach-Avoidance Task) as outlined in Chapter 6. Thus, the induction and consecutive employment of a negative interpretation style seemed to have led to a negative evaluation of the task-irrelevant facial crowd combinations, and had triggered an aversion/threat based avoidance response. In contrast to our findings in socially anxious individuals (Chapter 5), here the happy-angry crowds were not avoided. It was concluded that in social anxiety automatized negative evaluation of happy faces must be the result of an extensive

learning history of negative(ly interpreted) experiences with smiling people. Consequently, it might not be possible to reverse the naturally positive valence of a happy face with a negative interpretation training of an hour. Our study revealed the first evidence that an induced negative interpretation bias for ambiguous social scenarios could bring forth an avoidant behavior pattern similar to that observed in socially anxious individuals. These avoidance tendencies however, could only be reported in response to neutral-angry crowd combinations. In short, our results suggest that it is not necessary to have an inert threat evaluation of angry faces, a negative interpretation (training) seemed sufficient enough to let the angry faces appear even more negative and thus subjectively more relevant to surpass the threshold for an avoidance reaction.

## Integration

As cognitive models (Beck & Clark, 1997; Clark & Wells, 1995; Mathews & Mackintosh, 1998; Rapee & Heimberg, 1997) suggest that people suffering from social anxiety disorder have a tendency to interpret (ambiguous) social cues as being negative or threatening, it has been considered very likely that facial expressions being prominent communicative signals (Haxby et al., 2000; Öhman, 2002; Öhman, Flykt et al., 2001; Öhman & Mineka, 2001), must be relevant cues for threat inferences, too. Yet, research results as well as results from our own research that tested predictions based on the theoretical models have been indecisive/inconclusive.

Based on findings from Gilboa-Schechtman et al. (1999; but also: Hansen & Hansen, 1988; Öhman, Lundqvist et al., 2001) it has been suggested that angry faces are always preferentially processed, but that people high in social anxiety show a more accentuated attentional bias towards angry (read: threatening) faces or tend to evaluate such faces as more threatening/negative. Eye movement studies (Calvo et al., 2006; Garner, Mogg, & Bradley, 2006; Mogg, Millar, & Bradley, 2000; Rohner, 2002), studies employing exogenous cueing paradigms (Mansell et al., 1999; Mogg et al., 2004; Vassilopoulos, 2005), EEG-studies (Cooney, Atlas, Joormann, Eugene, & Gotlib, 2006; Kolassa et al., 2007; Rossignol et al., 2007) as well as expression categorization studies (Coles, 2004; Dimberg & Thunberg, 2007; Joormann & Gotlib, 2006; Lundh & Ost, 1996; Meyer, 2005) and emotion rating studies (Amir et al., 2005; Dimberg & Thunberg, 2007; Douilliez & Philippot, 2003; Gilboa-Schechtman et al., 2005; Merckelbach et al., 1989; Yoon & Zinbarg, 2007) could only partially confirm this claim (for literature overview see Table 1.1.; for review see: Fox, 2004b). Our own results could also confirm these claims only to a limited extend: we did *not* find disruption of threat-related covert attentional processes (vigilance, delayed disengagement, distraction, attentional narrowing) in response to particular facial expressions, neither in SAs nor in NACs. Further, SAs were not particularly good or bad in recognizing certain emotional expressions that were developing. Instead, they tended to misinterpret “disgust” as “contempt”, under conditions of enhanced ambiguity. In addition they tended, in contrast to NACs, to avoid angry as well as smiling faces in a crowd, while the direct evaluations of the displays did not reveal any group differences. Finally, negative interpretation training

led normal control participants to behave similar to SAs in response to angry faces: avoidant. Smiling faces, however, were not avoided.

Matters are complicated by reports of comparable findings in *trait* anxious but not in non-anxious participants in the literature. At the same time, *un*selected (non-anxious) individuals have shown processing differences for angry/negative faces, too (for critical discussion see: Fox, 2004b). Another unsettled issue results from to the employment of different not necessarily threat-related (usually: anger) but definitely negative facial expressions (fear, sadness, disgust). Fox (2004b) attempted to explain variations in research findings by the fact that scientists "… are not sampling stimuli that are of prime concern to high trait anxious people" (p.102). Additionally, even naturally positive emotions (happy, surprise) might undergo preferential processing, first, because they might be an invitation for desired social interaction, or a signal of sympathy and acceptance, etc. Herein, especially female smiles might be preferentially processed because females seem to play an evolutionary role in ensuring social coherence and warmth (Becker et al., 2007; Taylor et al., 2000; see also Chapter 3). At the same time smiles might have acquired a negative connotation over time by a sequence of negative experiences of an individual: Being often laughed at or having been ridiculed after misinterpreting a flirtatious smile could eventually, after numerous repetitions lead to a negative evaluation of a formerly positive expression (e.g., Chapter 6). In sum, there are numerous reasons why positive as well as negative emotional expressions might acquire a valence that leads to preferential processing. Therefore a negative evaluation of a stimulus can result in several somewhat contradictory behavioral consequences such as for example an attentional vigilance towards a stimulus as well as avoidance away from

it. Herein, may lay the core of inconsistencies throughout the literature. In social anxiety, the list of threat-evoking cues can be quite long and may vary greatly between individuals. Threatening stimuli are supposed to influence cognitive processes such as covert attention (Öhman & Mineka, 2001). While current cognitive models of social phobia (Clark & Wells, 1995; Rapee & Heimberg, 1997) begin at a point where a threatening cue or situation is present in one's environment, where the threat inference is about to be made or is already made, they do not take into consideration to what degree different levels of threat evaluation do or do not tamper threat-related processes.

In 1998 Mogg & Bradley introduced a cognitive-motivational model, which seems to resolve some of the aforementioned theoretical difficulties and describes processes that might precede those predicted by disorder specific theories. Mogg & Bradley suggested that all stimuli entering any of the sensory modalities are evaluated by a valence evaluation system integrating both, quick superficial feature analysis and slower detailed exploration of context, knowledge from experiences, etc. (e.g., LeDoux, 1996). Any given input receives a valence "tag", ranging from "no threat" to "high threat". According to this tag a "goal engagement system" motivates the subsequent course of action: Interrupt current goal and look for escape from danger, or pursue current goals because the stimuli do not warrant immediate action. The goal engagement system is thought to be responsible for the steering of subsequent cognitive processing such as i.e., attentional avoidance (with mild negative/threat valence) and attentional vigilance and dwelling (with high threat valence). Mogg and Bradley further assume that the sensitivity of the valence evaluation system can be altered by biological predisposition, the situational context,

experience, and character traits (see Figure 8.1). Mogg and Bradley's motivational model summarized here does not elaborate in detail how positive stimuli are processed by the valence evaluation system. Apparently, positive evaluations must feed into the goal engagement system, too, in order to prioritize positive stimuli or to interrupt striving for current goals and replace it by a better one. Just recently, Mogg and Bradley have endeavored to extrapolate their model (Mogg & Bradley, 2007a, 2007b). They hypothesize that the valence evaluation system must be imagined as

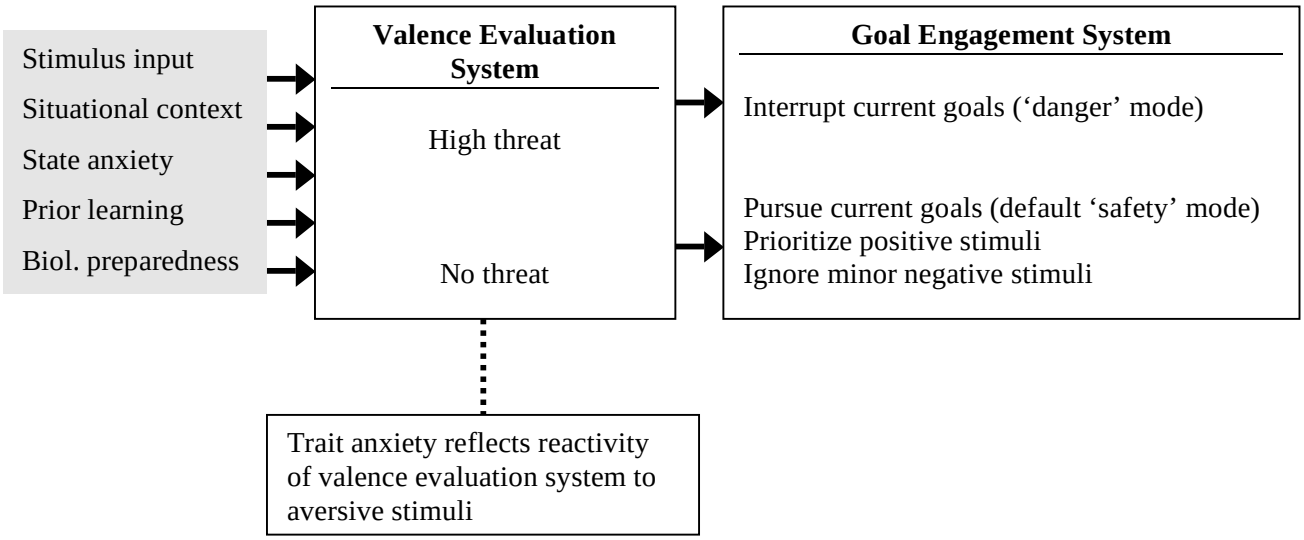


**Figure 8.1** *Reprinted from Mogg & Bradley (1998).*

an entity predicting degrees of reward and punishment on a continuous scale. Consequently, an organism that is motivated to pursue goals that either keep it away from punishment/negative experiences, or strive for reward/positive experiences, engages in avoidance (compare: Chapter 5-7) or approach behaviors. Those behaviors can manifest in covert, not observable actions such as for example relocation of covert attention, physiological arousal (e.g., preparation to fight, flight,

or freeze), cognitive processes (e.g., reappraisal; Chapter 4), but also observable behaviors such as (speeded) eye movements towards or away from stimuli as presented in Chapter 5, observable signs of physiological arousal (e.g., trembling), or approach and avoidance behaviors as presented in Chapter 6 and 7.

Mogg and Bradeley (2007b) contrasted anxiety and drug dependency to illustrate the model. While in anxiety prone individuals the detection of threat leads to interruption of the current goal pursuit in order to avoid expected harm, drug use in addicted individuals is associated with reward. Goal pursuits are also interrupted but are substituted by approach behavior. Both opposing evaluations can lead to cognitive distortions such as e.g., attentional biases *towards* the stimulus, but can lead to different observable behaviors: either approach or avoidance. It remains open to debate, which and how strong factors calibrate the valence evaluation system. As Mogg and Bradley (1998) asserted in the original paper, stimulus properties as well as the situational context and state anxiety might play an important role. Before those factors come into play, though, biological preparedness (Öhman et al., 1985; Seligman, 1971), but even more genetic predisposition (Lieb et al., 2000; Stein, Jang, & Livesley, 2002) and prior learning experiences (Neal & Edelmann, 2003) may have shaped someone's personality and sensitized the valence evaluation system in a way that makes an individual more or less anxious in a specific context with specific stimuli. Suitably, Derryberry and Reed (1994a; Derryberry & Reed, 1994b) have found correlations between temperament (extraversion and introversion) and attentional biases (disrupted disengagement) from positive and negatively tagged visual locations. Additionally, they suggested that temperamental differences in childhood are associated with the development of

motivational systems steering reward/approach and punishment/avoidance related behaviors but also corresponding attentional preferences. The fact that processing of facial expressions is sited in distinctive neurological structures, is highly automated (e.g., Haxby, Hoffman, & Gobbini, 2002; Vuilleumier & Pourtois, 2007) and that threat is rudimentarily processed via quick sub-cortical routes first (LeDoux, 1996), fits nicely with Mogg and Bradley's (1998) proposition that their motivational model primarily refers to preattentive and attentional processes. Nevertheless, the model appears tenable to explain other automatized cognitive behaviors as well and is nicely complemented by the ideas of Derryberry and Reed (1994a, 1994b).

On a more methodological level Fox (2004b) implied that stimulus material used in experimental psychopathological research, such as e.g., emotional faces, might not be relevant enough for a particular individual or for the tested population. It is possible that increased levels of e.g., trait anxiety do not necessarily bias attention towards (or away from) *angry faces*. In fact, this is only plausible if an unambiguous threat evaluation takes place and as a result a certain threat-threshold is surpassed. Even though angry faces might be evolutionarily determined threat signals, they do not inevitably trigger attentional vigilance or other threat-related phenomena as has been shown in Chapter 2-4. They only do so, if the individual ('s valence evaluation system) "considers" the stimulus and the context salient enough to be threatening. These "considerations" may be colored by former experiences, parenting style, cognitive style, but also genetic and evolutionary predisposition. They feed into, and fine-tune the valence evaluation system. Thus, angry faces may have some disruptive capacities in a search paradigm (e.g., Öhman, Lundqvist et al., 2001) or may be processed quicker than other emotions (Becker et al., 2007; our findings

Chapter 3), but they may not be equally threatening (read: “attention capturing”) to high trait anxious or socially anxious individuals (Chapter 2-4). Even though it is supposed that an increased degree of trait anxiety predisposes to a greater alertness for threat signals in general it remains unclear if that applies to angry faces. In the same line socially anxious individuals might be over alert for signals of social disapproval, but an angry face might after all be not as likely to occur or as threatening as long pauses in a conversation, someone turning away, one’s own signals of anxiety, not knowing what to say, being in the focus of others’ attention, etc.

Taken together, if an automatized, preattentive stimulus or input valence evaluation system as supposed by Mogg & Bradley (1998) really exists, it can readily explain the divergent findings summarized in this dissertation. When angry facial expressions are not necessarily evaluated as threatening by socially anxious participants, they may not impede threat-related attentional processing (Chapter 2 & 3) nor facilitate supposedly threat-relevant emotion recognition (Chapter 4). As these processes are assumed to take place on a preattentive, sub-cortical level, explicit evaluations will not show traces of implicit evaluation differences (Chapter 5 & 6). If a preattentive valence evaluation system appraises angry faces as unmistakably negative, they may still be processed faster in general (Chapter 3), or especially by socially anxious individuals (Chapter 5). A distinctly inflated negative evaluation does also make an avoidance impulse more plausible when the number of task-irrelevant emotional (angry) faces in a crowd increases (Chapter 6). Evidence is complemented by the fact that negative interpretation training *not* threat-

interpretation training in non-anxious individuals can result in avoidance impulses similar to those observed in socially anxious participants (Chapter 7).

## Limitations

So far, we have mainly considered the theoretical implications our findings could have. We are aware that some methodological constraints have to be considered as well. As more specific restrictions are discussed in each individual study, we will therefore reflect upon more general issues that are relevant for explanatory power and generalization.

First, all utilized pictures derived from the same KDEF (Lundqvist et al., 1998) picture set (except those in Chapter 2). It is imaginable that, if some of the pictures were flawed, in fact all studies would be unsound. It is possible that the presented pictures of Swedish actors might not be a good representation of facial characteristics or ethnicities in the Dutch population. Additionally, the depicted emotions could have been experienced as too intense, exaggerated, not recognizable, etc. Goeleven, De Raedt, Leyman, and Verschuere (2006), however, have recently investigated the validity of this particular picture set and concluded that "… despite the restriction in use with regard to cross-cultural studies and gender specificity, the good percentage idiosyncratic hit rate leads us to conclude that the KDEF pictorial databank is an extensive and easily applicable valid stimuli set of human affective facial pictures" (p. 15). Of course, it would be necessary to replicate our findings with a collection of different actors in order to verify the generalizations.

Second, we have to be aware that in most of our studies, the participant gender was female. This is a result of our participant recruitment mainly among psychology students, which are predominantly female. This hampers the generalization of our results considerably, and especially in the light of the gender-emotion interaction reported in Chapter 3, we feel that replication with a more balanced population is necessary.

Third, the selected pictures were predominantly male beginning with the third study. This choice was made after discovering that especially male angry faces were preferentially processed. It is plausible to assume that angry males are probably more threatening, especially to females. However, following our theoretical line of reasoning above, attentional biases or disruption of other attentional processes (e.g., IOR) should be more easily detectable with threatening male angry stimuli, while aversion related processes (e.g., approach-avoidance) should also be identified with angry female stimuli. For future research it will be a challenge to disentangle the effects of stimuli gender, anxiety proneness, and related cognitive biases.

Finally, it is important to know that in all reported experiments, only analogue participant samples were assessed. Here, we considered a high vs. low degree of social anxiety (usually, highest and lowest quartile of the distribution of Liebowitz Social Anxiety Scale [LSAS; Liebowitz, 1987] scores) sufficient to investigate the envisaged processes. Rapee and Spence (2004) suggested that social anxiety disorder must be seen as “relatively arbitrary cut” along a broader dimension or continuum (see also: Mattick & Clarke, 1998; Stein, Torgrud, & Walker, 2000; Turner, Beidel, Dancu, & Stanley, 1989). Following this line of reasoning, detection of cognitive biases in an analogue sample, might form an adequate precursor for

patient studies. Here, effects should be even stronger but not fundamentally different. As stated earlier, socially anxious students are much easier to recruit in a university environment, while recruitment of the patients demands considerably more time and resources. Besides that, the inclusion of social phobic patients brings about a large variety of comorbidity that has to be dealt with (Brunello et al., 2000; Chartier, Walker, & Stein, 2003; Stein & Chavira, 1998).

In sum, we felt that results from socially anxious but not diagnosed students can contribute sufficiently to the understanding of social phobia. Nevertheless, replication of our results with a clinical sample without comorbidity would be worthwhile to determine if the reported effects are indeed more pronounced.

So far, the discussion about limitations with regard to stimulus material, participant gender, and tested population is not resolved satisfactorily, and replication of our results with the aforementioned changes would be helpful to answer these open questions. However, the work at hand was not designed to clarify all possible methodological questions in investigating cognitive biases. Instead, our main interests were focused around evaluation differences between socially anxious and non-anxious individuals, and were tested in order to shed light on the question whether social anxiety is associated with distorted perception and evaluation of emotional faces.

## Conclusion

The aim of this thesis was to investigate in how far differential processing of emotional faces is mediated by the degree of social anxiety. Specifically, we

addressed different facets of potentially biased cognitive processes such as covert and overt visual attention, attentional disengagement, attentional narrowing, emotion recognition, approach-avoidance behavior and evaluation biases. Extensive experimental psychopathological research testing predictions of current cognitive theories could not convincingly evidence the extraordinary role of emotional (angry) facial expressions in the maintenance and maybe even etiology of social anxiety disorder. In fact, it appears that current theories need to incorporate a (preceding) step in which a social cue obtains its threatening value. Once such a cue is labeled as threatening, the whole cascade of negative assumption activation, awareness of anxiety, attention relocation, etc. can take place. In the light of the motivational model of anxiety discussed earlier (Mogg & Bradley, 1998) the results presented throughout this work give rise to the notion that emotional facial expressions, and especially angry faces might play a prominent though not necessarily threat-related role when processed by socially anxious individuals. It is suggested that they are solely labeled as entirely negative, and as such do not compellingly interfere with threat-related (covert) attentional processes. Although anxiety research still lacks a clear distinction between determinants of “threat-“ and “non-threat but negative” evaluations, it seems as if even angry faces are not intrinsically threatening to (all) socially anxious participants. If our assumptions about how threat evaluations influence cognitive processes and related behavior are correct, we have to assume that in our social anxious participants, angry faces are ”only” evaluated as disproportionally negative. In doing so, socially anxious individuals consistently show automatic negative evaluation or aversion as reflected in avoidance tendencies, but not necessarily attentional processes related to the presence of threat such as

diminished IOR or constriction of the attentional focus. Additionally, it has become evident that angry, but also happy facial expressions are evaluated differently from non-anxious controls, but only when responded to implicitly. Taken together we conclude that in social anxiety, facial expressions such as anger and happiness may acquire, due to a general genetic predisposition and learning history, a prominent negative evaluation which eventually becomes automated and ignites aversion-related, reflex-like behavioral tendencies such as avoidance, but which does not tab into conscious face evaluation processes. Thus, a negative interpretation style, as often observed in socially anxious individuals can lead to these reflexive behaviors in response to facial expression, but it is not mandatory. If so, however, it is likely, that such behavior is sensed by an interlocutor and interpreted on his part as rejection. Consequently, the interlocutor might behave more unfriendly or unsocial, which the socially anxious individual sees as fulfilling the prophecy of social rejection.

This research has helped to resolve a number of theoretical and methodological problems. The presented experimental investigation contributes to the refinement of cognitive models of social anxiety disorder and invites reconsideration of the current theoretical approaches. For future research, it will be essential to justify selections and determine clear benchmarks of experimental paradigms utilizing facial expressions. Additionally, the mechanisms that underlie and distinguish negative from threat evaluation have to be explored and refined. It has also become necessary to determine beforehand whether we intend to use threatening or “just” negative stimuli and which kind of outcome either one predicts. Especially for the research of social anxiety it remains open to debate whether facial expressions are the most suitable stimuli when investigating threat and its impact on

cognitive processes. Results might be confounded by “simple” negative evaluation of the faces. More clarity herein will promote more consistent results in research, broaden the understanding of the disorder and eventually lead to improved therapeutic interventions.

# Summary

People suffering from social anxiety disorder (social phobia) are constantly worried about how they come across to other people. Their foremost fear is to be rejected and eventually abandoned. They are markedly afraid to behave embarrassingly in social or social performance situations, presume to be evaluated negatively, and tend to avoid social situations if possible. Social anxiety disorder is the fourth most prevalent mental disorder and quite debilitating for the individual suffering from it. Cognitive theories indicate that social anxiety disorder is particularly characterized by a manifest tendency to interpret (ambiguous) social events or cues as negative or even threatening. Even though facial (emotional) expressions are believed to be evolutionarily valuable for communication and social (evaluative) feedback, evidence for biased processing of facial expressions in individuals with elevated degrees of social anxiety is far from coherent.

Goal of the present thesis was to shed light on these inconsistencies. Through the employment of different experimental paradigms we strove to explore implications of paradigm selection for theory forming and understanding of this debilitating disorder. In detail, we investigated distraction by, biased (automatic) responses to, and deviations in the recognition and direct evaluations of emotional and neutral faces. All findings were interpreted in the light of social anxiety levels. To achieve our goal, the following line of research was put forward:

*First (Chapter 2),* we started with a more general investigation, attempting to replicate findings showing that supposedly evolutionarily relevant threat cues, namely pictures of spiders and of angry faces, have the potential to draw and especially hold attention. We were specifically interested, whether other basic attentional processes (such as Inhibition of Return; IOR) were undermined. IOR refers to a hampering of initial visual attention to a previously scanned spatial location. IOR is believed to promote novelty in the visual field and make attentional processes more efficacious. If, on the other hand, detection of threat is prioritized in order to prepare an organism for quick appropriate responses, threatening stimuli in

a previously scanned location might still catch attention (vigilance) and hold attention (disrupted disengagement). Additionally, we investigated, whether alterations in IOR might be more pronounced in a population with fear for such stimuli (spider fearfulls and high socially but not clinically anxious). In none of the three experiments we found any evidence that IOR, is reduced by or absent due to threatening stimuli appearing in an earlier scanned visual location.

We concluded that IOR might be a process largely determined by “bottom-up”, perceptual information. However, stimulus valence is controlled “top-down” and might not have the time to interfere with bottom-up processes. The presented experimental set-up does not allow a conclusion about preferential attentional processing of threat stimuli in general. We can only conclude that a basic attentional process, such as IOR, does not seem to be affected by stimulus valence.

*Second (Chapter 3)*, it has been argued that patients suffering from anxiety disorders might show disrupted attentional disengagement rather than enhanced attentional vigilance: Patients display a disability in turning away their attention from a threatening cue. However, many employed experimental paradigms, such as for example the dot-probe task, neglect the possibility that full processing or identification of an emotion might be necessary before disengagement effects can occur. That is, only if the task demands full identification of the facial expression, e.g., by asking participants to *name* the depicted expression, it may become difficult to disengage one’s attention from a threatening face. Additionally, the reported findings of previous disengagement studies in the literature can also be attributed to a narrowing of attention once an individual is confronted with threatening material. By means of a flanker paradigm we, therefore, explored if threatening target stimuli, when fully processed, do indeed narrow the attentional field, and thus restrict the distractive influence of task irrelevant flanking stimuli. Additionally, we were interested if such an effect might be more pronounced in socially anxious individuals. We argued that if the diameter of the attentional focus constricts in response to a threat target, other stimuli in proximate spatial locations fall beyond the focus and are less apt to distract. Consequently, response latencies would decrease. If threatening faces would indeed capture attention than responses should be delayed for angry

flankers, when the target face was happy or neutral. Since angry faces are supposedly most threatening to socially anxious subjects, the effects of attentional narrowing should be most prominent in this population. To assure top-down stimulus recognition and threat evaluation, participants had to categorize the emotion of a target picture into angry, happy, or neutral, while the flanking faces had to be ignored.

Our results could not substantiate any attentional narrowing for angry face targets nor any increased distraction by angry face flankers.* Social anxiety was not relevant for any of the found effects, either. Thus, even if full processing of the cues is necessary to fulfill the task, responses to threatening target or flankers did not undergo preferential processing. It appears that emotional facial expressions are not perceived threatening to such a degree that they prompt attentional narrowing. Nor do they distract attention from a task such as emotion categorization. From the results up to this point we concluded that emotional faces might not necessarily be evaluated as threatening but that they nevertheless may be seen as more negative.

*Third (Chapter 4),* we argued that inconsistencies in reports of vigilance for threatening faces in social anxiety might stem from paradigm selection. Quick attention to angry faces might not necessarily manifest itself in quick detection of a "full-blown" facial expression. In fact, we thought it likely that socially anxious individuals might be particularly apt in detecting first signs of a (threatening) emotion very rapidly and (falsely) identify the gradually developing expression, even before it is completely visible. In two tasks participants watched movies of facial expressions gradually change from neutral to emotional (happy, angry, disgust). In the first task participants had to stop the movie as soon as they felt that the first signs of the emotion became visible. Then, without seeing the end of the film, they also had to guess, which emotion they thought would develop. In the second task, they were able to fast-forward or rewind through the whole movie and were asked to identify the point at which the facial expression changed from neutral to emotional. Here,

* Instead, we found an interaction of target gender and target emotion. Pictures of smiling females and angry males were faster categorized than angry females and smiling males. Though irrelevant for a better understanding of face processing in social anxiety, these findings do have important methodological implications for research utilizing facial expressions

they could see the full-blown emotion and were asked to identify it, too. The results of both tasks did not support the idea of either facilitated or impaired recognition of gradual facial affect change in socially anxious participants. However, we found that in the first task, socially anxious individuals when in error, mistake developing signs of disgust for contempt. Non-anxious controls, when wrong, rather interpreted the first signs of a disgust expression as happy. Thus, not the *number* of errors (per emotion) differed between the groups, but the *kind* of error.

In line with cognitive models of social phobia we found a relationship of social anxiety and a tendency to interpret ambiguous social information as negative. Facial expressions of disgust and contempt have previously been found to be quite similar. Therefore, it is possible that socially anxious tend to interpret the expressions congruent to their fears, when in doubt. In fact the task specific viewing restrictions artificially increased ambiguity and gave more room for these interpretations.

*Fourth (Chapter 5),* we aimed to answer the question which role overt attention may play in the evaluation of certain types of facial expressions. Consequently, we recorded the eye movements of participants while they observed a matrix of faces with different ratios of two intermixed expressions. We explored if the eye movements could predict participants' subjective evaluations and if those ratings were correlated with social anxiety. We found that social anxious participants fixated angry faces shorter than non-anxious controls. The subjective ratings, however, did not differ between the two groups. It remains unclear whether the observed biased processing is relevant for anxiety related behavior such as negative self-evaluation, negative evaluation of social scenes, or avoidance of social situations.

*Fifth (Chapter 6),* we sought to gain insight in evaluative processes not detectible with explicit ratings or attentional tasks. Instead, we investigated whether automatic behavior patterns such as approach and avoidance differ between socially anxious individuals and non-anxious individuals when responding to emotional facial crowds. We confronted socially anxious and non-anxious participants with a matrix of face stimuli (crowd) with changing ratios of neutral-angry, or happy-angry combinations. Participants were asked to sort the crowds according to their

background color by means of pulling (approach movement) or pushing (avoidance movement) a joystick, ignoring the depicted faces. As in our previous study, we contrasted those implicit responses with explicit subjective ratings of the same material. Socially anxious participants showed a tendency to react avoidant towards increasingly angry crowds. Additionally, they reacted avoidant when confronted with happy faces. Thus, it appeared that it was not possible for socially anxious individuals to ignore the emotional content of the crowds (though task irrelevant), whereas non-anxious controls were able to do so. They did not show any particular behavioral pattern in response to the task-irrelevant emotional faces. The explicit subjective ratings did not reveal any differences between groups. In sum, social anxiety seems to be associated with an initial avoidance response concerning emotional faces. Even generally positive faces such as smiling ones, are avoided.

*Finally (Chapter 7),* we addressed the sequence of cause and effect with regard to cognitive bias and anxious behavior: Is a cognitive bias a symptom of social anxiety such as e.g., avoidance behavior, or is it crucial in its etiology and cause of subsequent anxious behavior. We investigated whether an induced cognitive bias in a normal population, brings about implicit approach-avoidance tendencies that are similar to those of socially anxious individuals. We found that participants trained to hold a negative interpretation bias reacted similarly to angry faces than socially anxious participants did in the former study. Unlike observed in socially anxious individuals (Chapter 5), here the happy-angry crowds were not avoided as a whole. It was concluded that in social anxiety automatized negative evaluation of happy faces must be the result of an extensive learning history of negative(ly interpreted) experiences with smiling people. Such a drastic reversal of valence, we believe, is not accomplished within one hour of bias training. The study revealed the first evidence that an induced negative interpretation bias for ambiguous social scenarios could bring forth an avoidant behavior pattern similar to that observed in socially anxious individuals. These avoidance tendencies, however, could only be induced with respect to neutral-angry crowd combinations. Thus, it was not necessarily a “threat” evaluation that initiated avoidance; a negative evaluation seemed to be sufficient to surpass the threshold for an avoidance reaction.

Taken together, if an automated stimulus or input valence evaluation system really exists, and if it distinguishes between “threatening” and solely “negative” input, it can readily explain the divergent findings summarized in this dissertation. As covert visual attentional processes are thought to be sensitive to threat in the visual field, they may not be impeded when a stimulus is not evaluated as threatening (by socially anxious participants; Chapter 2 & 3). Accordingly, there is no harm to be protected from, and facilitated (early) emotion recognition is not necessary, either (Chapter 4). As human beings are apt to (quickly) avoid negative events and stimuli, the appraisal of angry faces as unmistakably negative, does not contradict faster recognition in the general population (Chapter 3), or avoidant overt eye movements in socially anxious individuals (Chapter 5). A distinctly inflated negative evaluation does also make an avoidance impulse more plausible when the number of (irrelevant) faces in a crowd increases (Chapter 6). Evidence is complemented by the fact that negative interpretation training in non-anxious individuals can result in avoidance impulses similar to those observed in socially anxious participants (Chapter 7).

## Discussion

The aim of this thesis was to investigate in how far differential processing of emotional faces is mediated by the degree of social anxiety. Specifically, we addressed different facets of potentially biased cognitive processes such as visual attention, attentional disengagement, attentional narrowing, emotion recognition, eye movements, approach-avoidance behavior and explicit ratings. Cognitive theories and extensive experimental psychopathological research so far could only unequivocally evidence the extraordinary role of emotional (angry) facial expressions in the maintenance and maybe even etiology of social anxiety disorder. The results presented throughout this work give rise to the notion that emotional facial expressions, and especially angry faces, might play a prominent though not necessarily threat-related role in the face processing of socially anxious individuals. Based on our findings we suggested that angry faces are solely seen as

unreasonably negative, and as such do not compellingly interfere with threat-related (covert) attentional processes. Although anxiety research still lacks a clear distinction between determinants of “threat-“ and “non-threat but negative” evaluations, it seems as if even angry faces are not intrinsically threatening to all socially anxious participants. If our assumptions about how threat evaluations influence cognitive processes and related behavior are correct, we have to assume that in our social anxious participants, angry faces are “only” evaluated as disproportionally negative. As a result, socially anxious individuals consistently show behaviors related to automatic negative evaluation or aversion such as avoidance tendencies. This does not necessarily imply that they display responses related to the presence of threat in the visual field such as diminished IOR or constriction of the attentional focus. Additionally, it has become evident that angry, but also happy facial expressions are evaluated differently from non-anxious controls, but only when responded to indirectly. Taken together, we conclude that in social anxiety, facial expressions such as anger and happiness may acquire, due to a general anxiety-prone genetic predisposition and learning history, a prominent negative evaluation. Such an evaluation eventually becomes automated and ignites aversion-related, reflex-like behavioral tendencies such as avoidance. These evaluative processes, however, do not tab into conscious face evaluation processes. It is very likely, though yet to be investigated, that such behavior is sensed by an interlocutor and interpreted on his part as rejection. Consequently, the interlocutor might behave more unfriendly or unsocially, which the socially anxious individual sees as fulfilling his or her own prophecy of social rejection.

## Conclusion

This research has helped to resolve a number of theoretical and methodological problems. The presented experimental investigation contributes to the refinement of cognitive models of social anxiety disorder and invites reconsideration of the current theoretical approaches. For future research, it will be essential to justify selections and determine clear benchmarks of experimental paradigms utilizing facial

expressions. Additionally, the mechanisms that underlie and distinguish negative from threat evaluation have to be explored and refined. It has also become necessary to determine beforehand whether we intend to use threatening or “just” negative stimuli and which kind of outcome either one predicts. Especially for the research of social anxiety it remains open to debate whether facial expressions are the most suitable stimuli when investigating threat and its impact on cognitive processes. Results might be confounded by “simple” negative evaluation of the faces. More clarity herein will promote more consistent results in research, broaden the understanding of the disorder, and eventually lead to improved therapeutic interventions.

# Samenvatting

Mensen met een sociale angststoornis (sociale fobie) maken zich voortdurend zorgen over hoe zij bij anderen overkomen. Het is hun grootste angst om afgewezen en uiteindelijk in de steek gelaten te worden. Ze zijn vooral bang om zich belachelijk te maken in sociale- of prestatiesituaties, verwachten negatief beoordeeld te worden en hebben daarom de neiging om sociale situaties te vermijden. De sociale angststoornis is een zeer belemmerende en de op vier na meest voorkomende psychische stoornis. Cognitieve theorieën veronderstellen dat de sociale angststoornis onder andere gekenmerkt is door een manifeste neiging om (ambigue) sociale gebeurtenissen of cues als negatief of zelfs bedreigend te interpreteren en deze cues vervolgens op een vertekende ("ge-biasde") manier te verwerken. Hoewel aangenomen wordt dat (emotionele) gezichtsuitdrukkingen een evolutionair waardevolle rol spelen in communicatie en bij sociale (evaluatieve) feedback, is het bewijs voor een vertekende/ge-biasde verwerking van gezichtsuitdrukkingen bij mensen met een verhoogd niveau van sociale angst niet eenduidig.

Het doel van de onderzoeken die in dit proefschrift beschreven worden was helderheid te scheppen over de in de literatuur gerapporteerde discrepanties. Door het gebruik van verschillende experimentele paradigma's onderzochten we de implicaties van paradigmakeuze voor theorievorming en begrip van deze invaliderende stoornis. De volgende vragen werden onderzocht: in hoeverre gaan emotionele en neutrale gezichtsuitdrukkingen de visuele aandacht afleiden van een uit te voeren taak; kunnen taakirrelevante afbeeldingen van gezichten automatische gedragstendensen beïnvloeden, zijn er vertekeningen te observeren in het herkennen van bepaalde gezichtsuitdrukkingen en hoe worden deze gezichten beoordeeld als men de deelnemers direct om hun mening vraagt. Alle resultaten werden geïnterpreteerd in het licht van het al dan niet aanwezig zijn van sociale angst. De onderzoekslijn wordt hieronder besproken.

*Allereerst (Hoofdstuk 2)* begonnen we ons onderzoek met een meer algemene aanpak. We probeerden eerdere bevindingen te repliceren die lieten zien

dat vermoedelijk evolutionair belangrijke bedreigende stimuli, namelijk plaatjes van spinnen en boze gezichten, de “normale” verwerking van deze stimuli vertekenen (genoemd: “aandachtsbias”). Specifiek werd verondersteld dat bedreigende stimuli visuele aandacht snel naar zich toe trekken (“vigilantie”) en deze buiten proportioneel lang vast houden (verstoorde “disengagement”) met als doel een organisme op een snelle en gepaste reactie voor te bereiden. We waren in het bijzonder geïnteresseerd of de verwerking van bedreigende stimuli andere basale aandachtsprocessen zoals “Inhibition of Return (IOR)” verstoort/reduceert. IOR verwijst naar een proces dat het opnieuw richten van de aandacht op een locatie die al is gezien bemoeilijkt. IOR faciliteert het schenken van aandacht aan nieuwe stimuli in het visuele veld waardoor aandachtsprocessen doelmatiger verlopen. In de literatuur word verondersteld dat IOR en vigilantie-effecten voor bedreigende stimuli niet samen kunnen optreden. Als een bedreigende stimulus prioriteit krijgt bij het naar zich toe trekken van aandacht, zal een dergelijke stimulus, ook in een eerder gescande locatie van het gezichtsveld, alsnog alle aandacht opeisen. IOR treedt dan niet of slechts in verminderde mate op. Bovendien waren we geïnteresseerd of mogelijke veranderingen in IOR sterker zijn als mensen specifiek bang zijn voor deze stimuli (spinnen voor mensen met spinnenangst en gezichten voor hoog sociaal angstigen). In geen van de drie experimenten hebben we bewijs gevonden dat IOR gereduceerd is wanneer bedreigende stimuli op al eerder gescande locaties van het gezichtsveld worden aangeboden.

We concludeerden dat IOR een proces is dat vooral “bottom-up” gecontroleerd wordt door perceptuele informatie van de stimulus zelf. De waardering van een stimulus wordt echter “top-down” (door cognitieve evaluatie in het brein) gecontroleerd en heeft vermoedelijk niet de tijd om te interfereren met bottom-up processen. De gekozen onderzoeksopzet maakt algehele conclusies met betrekking tot een aandachtsbias echter niet mogelijk. We kunnen slechts concluderen dat een basaal proces als IOR niet door bedreigende stimuli verstoord lijkt te worden.

*Ten tweede (Hoofdstuk 3)*, stelt men dat patiënten met een sociale angststoornis ten opzichte van een bedreigende stimulus vooral moeite hebben met verstoorde disengagement in plaats van verhoogde vigilantie voor deze stimuli. In de

literatuur onderschat men de mogelijkheid dat disengagement wellicht een grondige verwerking of identificatie van de emotie vereist: om de beoogde taak uit te kunnen voeren is het van belang dat de gebruikte emotionele gezichtsuitdrukking relevant is. Bij de, in dit soort onderzoek vaak gebruikte dot-probe taak, is dit niet nodig, waardoor de bevindingen wellicht niet eenduidig zijn. Bovendien zijn de wél gerapporteerde bevindingen rondom verstoorde disengagement ook te verklaren door een versmalling van de visuele focus wanneer een individu geconfronteerd wordt met een bedreigende stimulus. Door middel van een *flanker* paradigma hebben we onderzocht of bedreigende emotionele gezichtsstimuli, die gecategoriseerd moesten worden in blij, boos en neutraal en dus taakrelevant waren, leiden tot een versmalling van de visuele focus. Met dezelfde taak konden we ook onderzoeken of taakirrelevante, bedreigende perifere stimuli het uitoefenen van de taak bemoeilijken. We redeneerden dat als de visuele focus in reactie op bedreiging vernauwt, afleidende stimuli in de nabijee omgeving minder invloed hebben dan wanneer er geen vernauwing van focus optreedt. Reactietijden zouden dan kleiner moeten worden. Als de afleidende stimuli echter bedreigend zijn en de oorspronkelijke stimulus niet, zouden de reactietijden juist langer moeten worden. Wederom waren we geïnteresseerd of de verwachte effecten sterker zouden zijn bij mensen met sociale angst.

Er was geen bewijs voor een vernauwing van de visuele focus in reactie op boze gezichten noch dat boze gezichten meer afleidden van de taak dan andere expressies*. Kortom, ook al is de verwerking van de stimulus taak relevant, er is geen evidentie voor verstoringen in de aandacht en verwerking gevonden. Op basis van onze resultaten tot hiertoe vermoedden we dat emotionele gezichten niet zo zeer onderwerp zijn van bedreiginginterpretaties maar dat ze desondanks als zeer negatief worden ervaren.

* Wel vonden we een interactie van geslacht van een persoon op een stimulusfoto met de door hem of haar getoonde expressie van het afgebeelde gezicht. Foto's van lachende vrouwen en boze mannen werden sneller gecategoriseerd dan boze vrouwen en blije mannen. Ondanks dat deze resultaten irrelevant zijn voor het begrijpen van gezichtsverwerking bij sociaal angstigen, hebben deze bevindingen verstrekkende methodologische implicaties voor onderzoek dat gebruik maakt van gezichtsuitdrukkingen.

*Ten derde (Hoofdstuk 4)*, veronderstelden we dat de inconsistenties in de bevindingen omtrent vigilantie en boze gezichten bij sociaal angstigen met de keuze van het experimentele paradigma te maken zou kunnen hebben. Versnelde aandacht voor boze gezichten manifesteert zich niet noodzakelijk in een versnelde detectie van “full-blown” gezichtsuitdrukkingen, maar mogelijk juist in het herkennen van de eerste tekenen van een (boze) emotie bij een zich geleidelijk ontwikkelende expressie. Mogelijk ook dat sociaal angstigen deze eerste tekenen van een (boze) emotie vaker verkeerd identificeren. In twee taken bekeken deelnemers films waarin een neutrale gezichtsuitdrukking geleidelijk veranderde in een blije, boze of walgende expressie. In de eerste taak stopten de deelnemers de film zodra ze meenden de eerste tekenen van een emotie te herkennen. Zonder het einde van de film te hebben gezien moesten ze gokken welke emotie zich volgens hen ging ontwikkelen. In de tweede taak zagen ze dezelfde film, maar hadden ze de vrijheid om de hele film heen en terug te “spoelen”, het einde te zien en dan alsnog het punt op te zoeken waarop zij meenden dat de gezichtsuitdrukking van neutraal naar emotioneel geladen omsloeg. Hierna konden ze weer teruggaan naar het einde van de film om te bepalen welk emotie zij dachten dat er getoond werd. Beide taken leverden geen bewijs voor een beterde of slechtere herkenning van gradueel veranderende gezichtsuitdrukkingen bij sociaal angstige mensen in vergelijking met niet angstige controle personen. Wel vonden we dat de eerste tekenen van walging (taak 1) door sociaal angstigen vaker geïnterpreteerd werden als afwijzing, terwijl niet-angstigen deze tekenen van walging interpreteerden als tekenen van blijdschap. Het is dus niet het aantal fouten dat het verschil tussen groepen bepaalde, maar het soort fouten.

In overeenstemming met cognitieve modellen van sociale fobie hebben we een samenhang gevonden tussen sociale angst en de neiging om ambigue sociale informatie negatief te interpreteren. Het is al eerder geconstateerd dat gezichtsuitdrukkingen zoals walging en afwijzing sterk op elkaar lijken. Het is dus denkbaar dat sociaal angstige, in geval van twijfel, expressies in overeenstemming met hun angsten interpreteren. De taakspecifieke beperkingen in beschikbare

informatie voor de proefpersoon zou de ambiguïteit kunstmatig verhoogd kunnen hebben, waardoor er meer ruimte was voor interpretatie.

*Ten vierde (Hoofdstuk 5)*, wilden we de vraag beantwoorden welke rol “overte” (door oogbewegingen traceerbare) aandacht speelt bij de evaluatie van bepaalde soorten expressies. Daartoe hebben we oogbewegingen bij deelnemers gemeten terwijl zij naar matrices van gezichten (“crowds” genoemd) keken die verschillende verhoudingen van twee expressies bevatten (bijvoorbeeld een combinatie van 9 blije en 3 neutrale gezichten). De deelnemers moesten de crowds beoordelen op vriendelijkheid. We onderzochten in hoeverre de oogbewegingen de beoordelingen konden voorspellen en of dit samen hing met sociale angst. We vonden dat sociaal angstige deelnemers korter naar boze gezichten keken dan niet-angstigen. De subjectieve beoordelingen verschilden echter niet tussen de groepen. Het blijft verder onduidelijk of de geobserveerde verkorte aandacht voor boze gezichten in sociaal angstigen relevant is voor angst gerelateerde gedragingen zoals bijvoorbeeld zelfevaluatie, negatieve interpretatie, of vermijding van sociale situaties.

*Ten vijfde (Hoofdstuk 6)*, trachtten we inzicht te krijgen in evaluatieve processen die niet door middel van expliciete beoordeling of aandachtstaken op te sporen zijn. Feitelijk onderzochten we of automatische gedragspatronen zoals toenaderings- en vermijdingstendensen verschillen tussen sociaal angstige en niet-angstige individuen wanneer zij reageren op groepen van emotionele gezichten. We presenteerden de proefpersonen wederom matrices van gezichten met veranderende verhoudingen tussen neutraal-boze of blij-boze gezichten. De stimuli waren voorzien van een rode of bruine achtergrondkleur en aan de deelnemers werd gevraagd om de plaatjes op basis van die kleur met een joystick te sorteren ongeacht de emotionele uitdrukking van de gezichten: bij de ene kleur naar je toe trekken (toenadering), bij de andere van je weg duwen (vermijding). Zoals in de vorige studie moesten de deelnemers de crowds na de joysticktaak op vriendelijkheid beoordelen. Sociaal angstigen reageerden meer vermijdend naarmate in een neutrale groep het aantal boze gezichten toenam ondanks de opdracht de emoties van gezichten te negeren. Bij de blij-boze combinaties

reageerden ze overal vermijdend. Het blijkt dat sociaal angstige individuen emoties in het algemeen, zelfs als ze positief zijn, vermijden.

*Tot slotte (Hoofdstuk 7)*, hebben we gepoogd de oorzaak-gevolg relatie van vertekeningen (biases) in de cognitieve verwerking en angstgerelateerd gedrag te onderzoeken: is een dergelijke vertekening bij de informatieverwerking nou een symptoom van sociale angst zoals bijvoorbeeld vermijdingsgedrag, of speelt een cognitieve bias een cruciale rol bij de etiologie die uiteindelijk leidt tot de sociale angst stoornis. Door middel van een bias-inductie in een normale populatie wilden we onderzoeken of toenaderings- of vermijdingstendensen uitgelokt konden worden. We vonden dat deelnemers die getraind werden om sociale informatie negatief te interpreteren ("negatieve interpretatiebias"), op een vergelijkbare manier neutraal-boze groepen gingen vermijden als sociaal angstigen in het vorige onderzoek (Hoofdstuk 6). In vergelijking met de bevindingen voor de blij-boze combinaties uit het vorige onderzoek, werden hier geen reactieverschillen gevonden tussen de groepen (hier: positief en negatief getrainde). We concludeerden dat bij sociale angst de geautomatiseerde vermijding van blije gezicht het resultaat moet zijn van een uitgebreide leergeschiedenis met negatieve, of wellicht negatief geïnterpreteerde, ervaringen met lachende mensen. Met één uur trainen zoals we in het onderzoek hebben gedaan, hebben wij vermoedelijk van de van oorsprong positieve valentie van blije gezichten niet om kunnen keren. Deze studie leverde wel de eerste bewijzen op dat een geïnduceerde negatieve interpretatiebias voor ambigu sociaal materiaal kan resulteren in vermijdende gedragspatronen vergelijkbaar met die van sociaal angstigen. Dit effect was echter beperkt tot de responsen op neutraal-boze stimuli. Hieruit concludeerden we dat het niet noodzakelijk om een evaluatie van bedreiging gaat die vermijding initieert, maar dat een negatieve evaluatie voldoende is om de drempel voor een vermijdingsreactie te passeren.

Concluderend, als er inderdaad een geautomatiseerd cognitief systeem bestaat dat elke stimulus of input evalueert en als het systeem kan differentiëren tussen "bedreigende" en "negatieve" elementen, dan kan dit onze uiteenlopende bevindingen verklaren. Omdat visuele aandachtsprocessen verondersteld worden vooral sensitief te zijn voor bedreiging, is het aannemelijk dat ze niet beïnvloed

worden door stimuli die door sociaal angstigen slechts als negatief beoordeeld worden (Hoofdstuk 2 & 3). Er is geen dreigend gevaar waartegen het organisme onmiddellijk beschermt dient te worden. Vroegtijdige herkenning van (eerste tekenen van) emotionele gezichtsuitdrukkingen is dan ook niet nodig (Hoofdstuk 4). Omdat de mens wél geneigd is om negatieve situaties en stimuli (zo snel mogelijk) te vermijden, en boze gezichten duidelijk negatief zijn, spreekt het de gevonden snellere categorisatie in de normale populatie (Hoofdstuk 3), of specifiek bij sociaal angstigen, niet tegen (Hoofdstuk 5). In feite maakt een sterke negatieve evaluatie een vermijdingsimpuls meer plausibel wanneer het aantal (irrelevante) negatieve gezichten in een groep toeneemt (Hoofdstuk 6). Aanvullend bewijs wordt geleverd door het feit dat een inductie van een negatieve interpretatiebias in een normale populatie resulteerde in vermijdingstendensen vergelijkbaar met die van sociaal angstige individuen.

## Discussie

Het doel van de in dit proefschrift beschreven studies was om te onderzoeken in hoeverre de verwerking van emotionele gezichten beïnvloed werd door de mate van sociale angst. We hebben verschillende facetten van mogelijk vertekende cognitieve processen aan de orde gesteld: namelijk visuele aandacht, disengagement van aandacht, aandachtsvernauwing, emotie herkenning, oogbeweging, toenaderings- en vermijdingstendensen en expliciete/subjectieve beoordelingen. Cognitieve theorieën en uitgebreid experimenteel psychopathologisch onderzoek konden tot op heden maar beperkte aanwijzingen vinden dat de verwerking van emotionele (boze) gezichtsuitdrukkingen een belangrijke rol spelen bij het in stand houden, maar misschien ook het ontstaan, van de sociale angststoornis. De resultaten die in dit proefschrift gepresenteerd worden laten zien dat emotionele gezichtsuitdrukkingen, en specifiek boze gezichten, een prominente, maar niet noodzakelijk op bedreiging gerichte, rol kunnen spelen bij de verwerking van gezichten bij sociaal angstige individuen. Gebaseerd op onze bevindingen, denken wij dat boze gezichten alleen als “overdreven” negatief gezien worden en daardoor niet interfereren met een

bedreiginggerelateerd proces zoals (verdekte [“covert”]) aandacht. Ondanks het feit dat binnen angstonderzoek criteria ontbreken om “bedreigend“ en “niet-bedreigend maar negatief” duidelijk van elkaar te scheiden, duiden onze bevindingen erop dat boze gezichten niet intrinsiek bedreigend zijn voor alle sociaal angstigen. Als onze assumpties kloppen met betrekking tot hoe bedreigingbeoordelingen cognitieve processen en gerelateerd gedrag beïnvloedden, moeten we aannemen dat sociaal angstige proefpersonen boze gezichten “slechts” als disproportioneel negatief evalueerden. Daarom laten sociaal angstige individuen consistent gedrag zien dat gerelateerd is aan automatische negatieve beoordeling of aversie zoals vermijdingstendensen. Dat betekent niet noodzakelijkerwijs dat ze responsen laten zien die blijk geven van bedreiging in het visuele veld zoals een vermindering in IOR of aandachtsvernauwing. Bovendien kon aangetoond worden dat naast boze ook blije gezichtsuitdrukkingen negatiever beoordeeld worden door sociaal angstigen dan door niet-angstigen. Samengenomen, concluderen we dat bij sociale angst gezichtsuitdrukkingen zoals boosheid of blijdschap, door een leergeschiedenis en een algemene angstneiging die genetisch gepredisponeerd is, een prominente negatieve evaluatie ondergaan. Een dergelijk proces raakt geautomatiseerd en initieert aversiegerelateerde, reflexmatige gedragstendensen zoals vermijding, maar leidt niet tot veranderingen van bewuste gezichtsbeoordelingsprocessen. Het is mogelijk, ook al moet dit nog onderzocht worden, dat een gesprekspartner dit soort subtiel gedrag bij een sociaal angstig persoon waarneemt en als afkeur interpreteert. Vervolgens zou de gesprekspartner zich dan onvriendelijk en afwijzend kunnen gedragen wat de sociaal angstige als een bevestiging van zijn verwachting te worden afgewezen kan zien, wat zijn of haar angst weer versterkt.

## Conclusie

Dit onderzoek heeft licht geworpen op een aantal theoretische en methodologische problemen. De resultaten helpen om de cognitieve modellen over de sociale angststoornis aan te scherpen en nodigt uit de theoretische kaders te overdenken. Voor de toekomst is het cruciaal om de keuzes en

randvoorwaarden bij de inzet van experimentele paradigma's die van gezichten gebruik maken duidelijk te omschrijven. Ook moeten de mechanismen die ten grondslag liggen aan een negatieve of een bedreigingbeoordeling uitgezocht en (opnieuw) gedefinieerd worden. Het is belangrijk om van tevoren te bepalen of men bedreigende of "slechts" negatieve stimuli wil gaan gebruiken en welke uitkomst men van elk verwacht. Voor het onderzoek naar sociale angst, resteert de vraag of gezichtsuitdrukkingen de meest geschikte stimuli vormen als men bedreiging en zijn invloed op cognitieve processen wil onderzoeken. De resultaten zouden verstoord kunnen zijn bij een prominente negatieve beoordeling. Meer duidelijkheid zal uiteindelijk leiden tot meer consistente onderzoeksresultaten, een beter begrip van de sociale angststoornis, en ten slotte verbeterde therapeutische interventies.

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# Curriculum Vitae

Wolf-Gero Lange was born on the first of March in 1972 in Würselen, Germany. He finished from secondary school (Gymnasium Würselen) in Würselen in 1992. After having studied electronical engineering at the Rheinisch Westfälische Technische Hochschule in Aachen (Germany) for a half year, he completed a study of social work at the Fachhochschule Niederrhein in Mönchengladbach (Germany) to finally start his study of psychology at the Universiteit Maastricht in the Netherlands. In October 2004 he received his Masters Degree in (Biological) Psychology. During his study of psychology, he also worked as research and teaching assistant, and as trainee at the Klinikum Aachen (Germany) to develop his psychodiagnostic skills. In April 2004 he stared his PhD project at the Behavioral Science Institute of the Radboud Universiteit Nijmegen (The Netherlands), resulting in this thesis. In the same period he worked as science practitioner at the institute's ambulatorium and started his training as a behavioral and cognitive therapist at the RINO Group in Utrecht. Since June 2008 he is employed as Assistant Professor at the Department of Clinical Psychology of the Open Universiteit Nederland.

# Publications


Lange, W.-G., Becker, E.S., & Rinck, M. (in preparation). *Disengagementprobleme bei Sozialer Angst*.

Lange, W.-G., Heuer, K., Langner, O., Becker, E.S., & Rinck (2008). *Here's looking at you, folks: Eye movements and the evaluation of facial crowds in social anxiety*. Manuscript submitted for publication.

Lange, W.-G., Heuer, K., Keijsers, G.P.J, Rinck, M., & Becker E.S. (in preparation). *Morphed emotions: Emotion detection and misinterpretation in social anxiety*.

Lange, W.-G., Heuer, K., Reinecke, A., Becker, E.S., & Rinck, M. (2008). Inhibition of return is unimpressed by emotional cues. *Cognition & Emotion, 22*(8), 1433-1456.

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Lange, W.-G., Keijsers, G.P.J, Rinck, M., & Becker, E.S. (2008). *Distracting emotions: Angry women and smiling men disturb target categorization*. Manuscript submitted for publication.

Lange, W.-G., Salemink, E., Becker, E.S., & Rinck, M. (2007). *Induction of interpretation bias influences behavior: Implicit evaluation of emotional faces similar to that in Social Phobia*. Manuscript submitted for publication.

Roelofs, K., Putman, P., Schouten, S., Lange, W.-G., van Peer, G., & Rinck, M. (in preparation). *Gaze direction affects approach-avoidance behavior to angry faces and not to happy faces.*

Vrijsen, J.N., Lange, W.-G., Dotsch, R., Wigboldus, D., & Rinck, M. (2008). *How do socially anxious evaluate a mimicking avatar?* Manuscript submitted for publication.

# Conference Presentations

Lange, W.-G., Vrijsen, J.N., Dotsch, R., Wigboldus, D., Rinck, M., & Becker, E.S. (November, 2008). Mimicry and social anxiety - News from the VR lab. In M. Voncken (Chair), *Wanneer vinden we elkaar nu eigenlijk aardig? Sociale anststoorniss en werkwijze in exposure behandeling*. Symposium conducted at the 'najaarsconferentie' of the Vereniging voor Gedragstherapie en Cognitieve Therapie [VGCT], Veldhoven (NL).

Lange, W.-G., Vrijsen, J.N., Dotsch, R., Wigboldus, D., Rinck, M., & Becker, E.S. (May, 2008). Mimicry and social anxiety - News from the VR lab. In A. Reinecke (Chair), *New approaches in investigating biased interpretation in mental disorders.* Symposium conducted at the 'Annual conference of the British Association of Behavioural and Cognitive Psychology [BABCP], Edinburgh (GB).

Lange, W.-G., Vrijsen, J.N., Dotsch, R., Wigboldus, D., Rinck, M., & Becker, E.S. (May, 2008). Mimicry and social anxiety - News from the VR lab. In E. Koster (Chair), *Cognitive biases in emotional disorders*. Symposium conducted at the 'Annual meeting of the Belgium Association for Psychological Science [BAPS], Leuven (B).

Lange, W.-G., Vrijsen, J.N., Dotsch, R., Wigboldus, D., Rinck, M., & Becker, E.S. (May, 2008). Mimicry and social anxiety - News from the VR lab. In A. Mühlberger (Chair), *Virtual environments for therapy and research on anxiety disorders*. Symposium conducted at the 'Fachgruppentagung' of the 'Fachgruppe Klinische Psychologie und Psychotherapie der Deutschen Gesellschaft für Psychologie, Potsdam (G).

Lange, W.-G., Salemink, E., Becker, E.S., & Rinck, M. (2007, December). *Negative interpretation training affects approach-avoidance tendencies: A model for social anxiety?* Poster session presented at the opening meeting of the FWO scientific Research Community: 'Automatic processes in psychopathology, and health related behavior', Ghent, Belgium.

Lange, W.-G., Dotsch, R., Wigboldus, D., Keijsers, G.P.J., Rinck, M., & Becker, E.S. (2007, November). Virtual reality and social anxiety. In M. Voncken (Chair), *Kwetsbare eigenschappen van mensen met sociale angst (stoornis): implicaties voor behandeling*. Symposium conducted at the 'najaarsconferentie' of the Vereniging voor Gedragstherapie en Cognitieve Therapie [VGCT], Veldhoven (NL).

Lange, W.-G., Salemink, E., Becker, E.S. Keijsers, G.P.J., & Rinck, M. (2007, November). Do trained approach-avoidance tendencies model social anxiety? In W.-G. Lange (Chair), *Kwetsbare cognities: Hoop door cognitieve training?* Symposium conducted at the 'najaarsconferentie' of the VGCT, Veldhoven (NL).

Lange, W.-G., Salemink, E., Becker, E.S., & Rinck, M. (2007, October). *Negative interpretation training affects approach-avoidance tendencies: A model for social anxiety?* Poster session presented at the Dutch-Flemish postgraduate school for research and education [EPP] day: 'Psychopathology and motivational tendencies of approach and avoidance', Utrecht (NL).

Lange, W.-G., Becker, E.S., Keijsers, G.P.J., & Rinck, M. (2007, July). Automatic action tendencies in high and low socially anxious individuals contradict results from explicit ratings. In P. de Jong (Chair), *Automatic approach-avoidance tendencies in anxiety, eating disorders, and addiction: Theoretical meaning and clinical implications*. Symposium conducted at the World Congress of Behavioral Cognitive Therapy [WCBCT], Barcelona, Spain.

Lange, W.-G., Becker, E.S., Salemink, E., Keijsers, G.P.J., Rinck, M., & Becker, E.S. (2007, June). *Approach-avoidance tendencies and social anxiety.* Oral presentation at the annual research day of the Behavioural Science Institute [BSI], Nijmegen (NL).

Lange, W.-G., Salemink, E., Becker, E.S., & Rinck, M. (2007, May). *Negative interpretation training affects approach-avoidance tendencies: A model for social anxiety?* Poster session presented at the 'Workshopkongress' of the Fachgruppe Klinische Psychologie und Psychotherapie der Deutschen Gesellschaft für Psychologie, Tübingen (G).

Lange, W.-G., Rinck, M., & Becker, E.S. (2007, April). Memory performance and memory bias in Major Depression. In I. Tendolkar (Chair), *Hormones, mood and memory: A multidimensional approach unravelling the neurobiology of depression.* Symposium conducted at the 35e 'Voorjaarscongres' of the Nederlandse Vereniging voor Psychiatrie [NVvP], Maastricht (NL).

Lange, W.-G., Keijsers, G.P.J., Becker, E.S., & Rinck, M. (2006, November). Approach & Avoidance bij sociaal angstigen. In P. de Jong (Chair), *Alles onder controle? Automatische processen en sociale angst.* Symposium conducted at the 'najaarsconferentie' of the VGCT, Veldhoven (NL).

Lange, W.-G., Becker, E.S., Keijsers, G.P.J., & Rinck, M. (2006, September). Gradual approach-avoidance tendencies in social anxiety. In M. Voncken (Chair), *Cognitive biases in social phobia*. Symposium conducted at the annual congress of the European Association of Behavioral Cognitive Therapy [EABCT], Paris, France.

Lange, W.-G., Becker, E.S., Keijsers, G.P.J., & Rinck, M. (2006, September). *Approach-avoidance tendencies as measure of evaluation in social anxiety*. Poster session presented at the annual congress of the EABCT, Paris, France.

Lange, W.-G., Becker, E.S., Keijsers, G.P.J., & Rinck, M. (2006, September). *Approach-avoidance tendencies as measure of evaluation in social anxiety*. Poster session presented at the EPP '10 jaar jubileum symposium', Den Bosch (NL).

Lange, W.-G., Becker, E.S., Keijsers, G.P.J., & Rinck, M. (2006, June). *'Group pressure': Approach-avoidance tendencies as measure of evaluation in social anxiety*. Poster session presented at the annual research day of the BSI, Nijmegen (NL).

Lange, W.-G., Becker, E.S., Keijsers, G.P.J., & Rinck, M. (2006, May). Avoidance of groups in social anxiety. In M. Rinck (Chair), Indirekte Verfahren der Angstdiagnostik in der Klinischen Psychologie. Symposium conducted at the 'Fachgruppentagung' of the 'Fachgruppe Klinische Psychologie und Psychotherapie der Deutschen Gesellschaft für Psychologie, Würzburg (G).

Lange, W.-G., Keijsers, G.P.J., Becker, E.S., & Rinck, M. (2005, November). Social Phobia - Interpretation of group mood is spoiled by one face. In M. Voncken (Chair), *Sociale fobie: Nieuwe inzichten in cognitieve processen en de implicaties hiervan voor behandeling*. Symposium conducted at the 'najaarsconferentie' of the VGCT, Veldhoven (NL).

Lange, W.-G., Becker, E.S., & Rinck, M. (2005, September). Boundary conditions of attentional biases in specific phobia. In A. Gerlach's (Chair) Symposium conducted at the annual congress of the EABCT, Thessaloniki, Greece.

Lange, W.-G., Becker, E.S., Keijsers, G.J.P., & Rinck, M. (2005, September). *Social Phobia - Interpretation of group mood is spoiled by one face.* Poster session presented at the annual congress of the EABCT, Thessaloniki, Greece.

Lange, W.-G., Becker, E.S., Keijsers, G.P.J., & Rinck, M. (2005, June). *Interpretation of group-mood is spoiled by one face. Interpretation bias in social phobia*. Poster session presented at the annual research day of the BSI, Nijmegen (NL).

Face Value - Processing of Emotional Expressions in Social Anxiety

Wolf-Gero Lange